INSTRUCTION MANUAL

Serial Number ____________

146/R146
NTSC TEST SIGNAL GENERATOR

Tektronix, Inc. ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-1111-00

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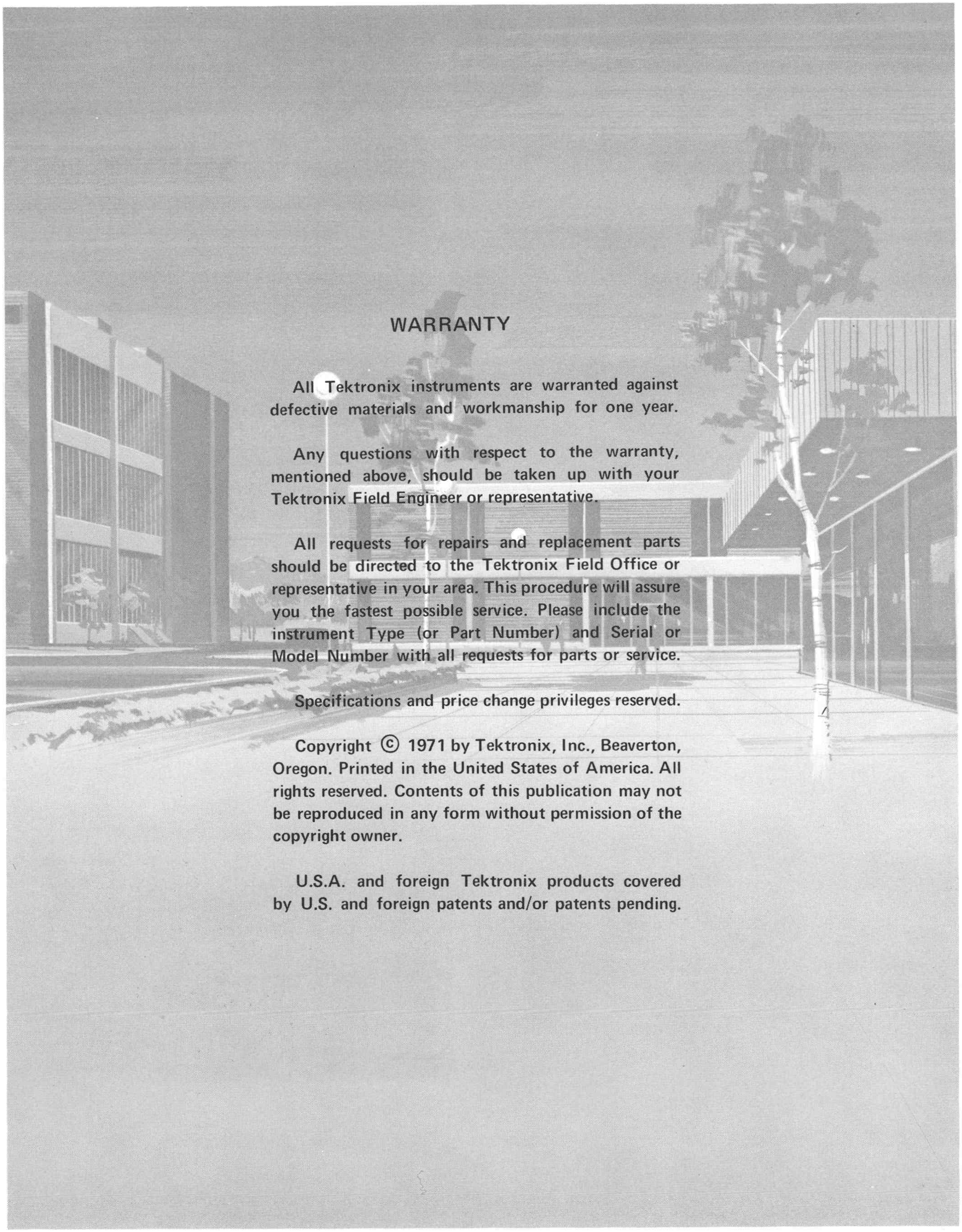

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty, mentioned above, should be taken up with your Tektronix Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

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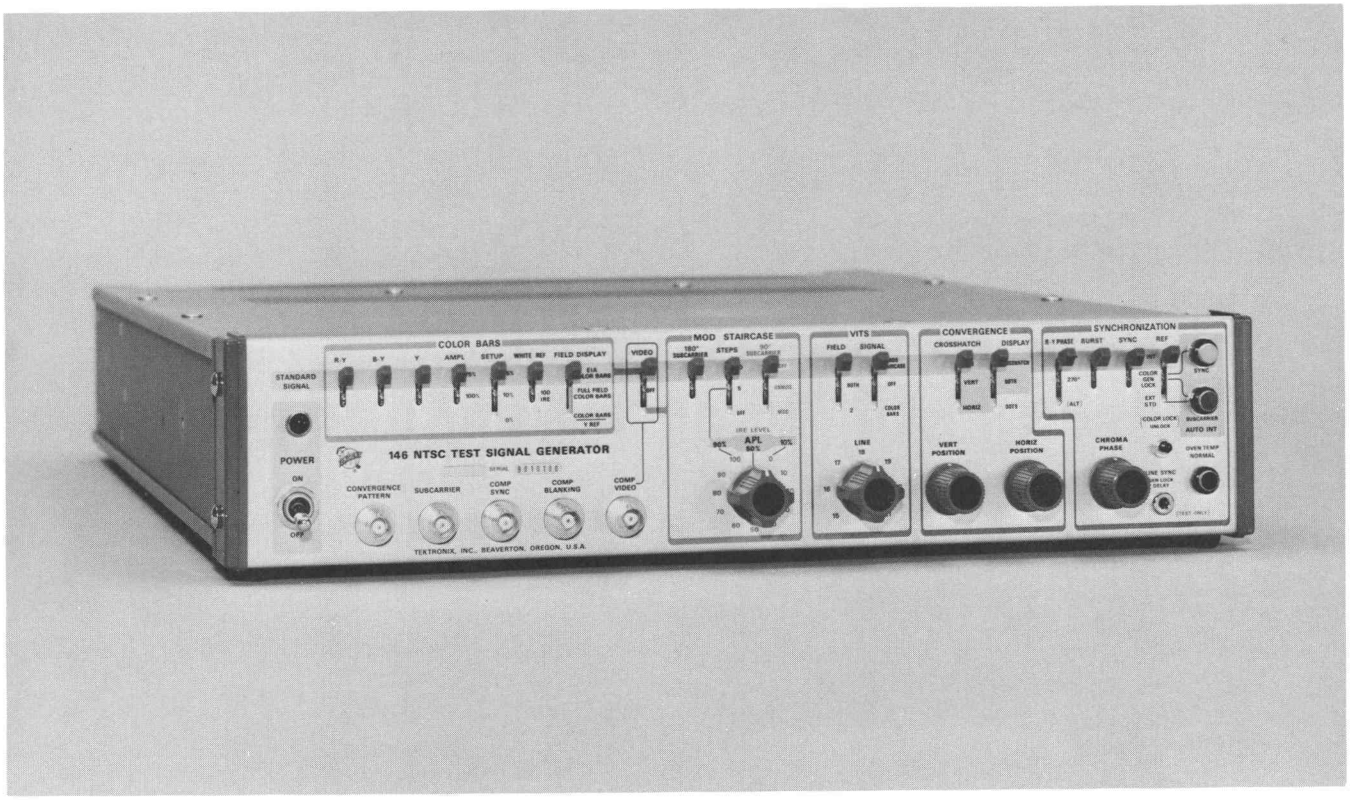
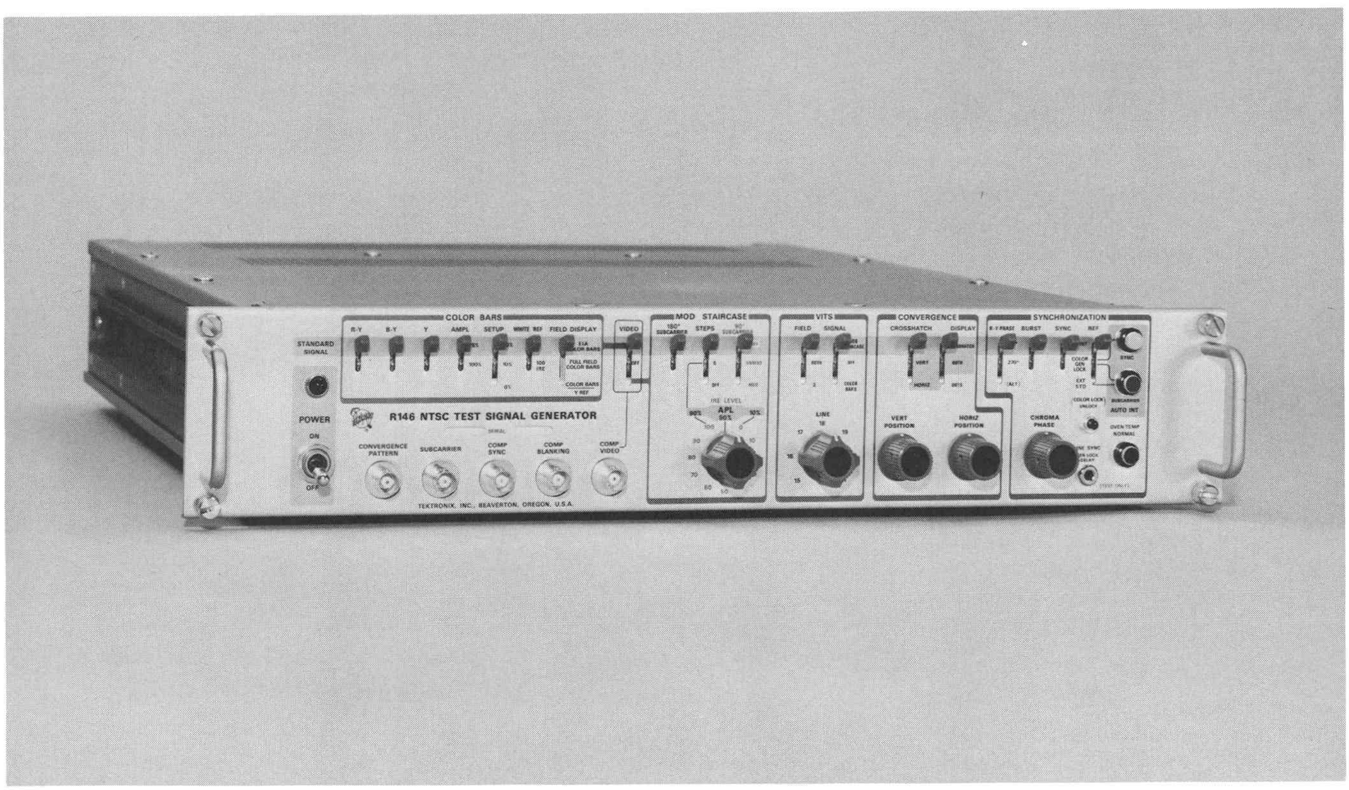
Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.



(A) 146 NTSC TEST SIGNAL GENERATOR (Bench Model).



(B) R146 NTSC TEST SIGNAL GENERATOR (Rackmount Model).

Fig. 1-1. The two models of the generator are electrically identical.

SECTION 1
SPECIFICATION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

The 146[1] NTSC[2] TEST SIGNAL GENERATOR is a source of television test signals for 525-line, 60-Hz field standard NTSC color television systems.

Two operating modes provide either color bar or staircase test signals. In the COLOR BARS mode, three (user-selected) signals are available: EIA COLOR BARS, FULL FIELD COLOR BARS, and COLOR BARS/Y REF. In the staircase mode, two (user-selected) signals are available: 10 step (11 levels) with APL (Average Picture Level) selectable, and 5 step (6 levels) with APL fixed or selectable.

A CONVERGENCE PATTERN signal is available independent of all other output signals. The signal conforms to IRE (Institute of Radio Engineers) standard 54-23S1 on measuring scanning geometry and aspect ratio.

[1]**The 146/R146 are electrically identical. The 146 will be referred to in this manual.**

[2]**National Television System Committee.**

Provision is made for the 146 to be Gen-Locked (see Glossary of Terms, Section 2) to composite video from another source. Alternately, an externally generated CW subcarrier source may be substituted for the internal 3.58 MHz standard. Black Burst is available.

Other output signals are: SUBCARRIER, COMP SYNC, COMP BLANKING, BURST FLAG, HORIZ DRIVE, and VERT DRIVE.

ELECTRICAL CHARACTERISTICS

Performance Conditions

The specified limits of the instrument calibration characteristics are valid with the following conditions: the instrument must have been calibrated at an ambient temperature between +20°C and +30°C, operated within an ambient temperature of 0°C to +50°C, and must have a warm-up period of at least 10 minutes.

TABLE 1-1

STAIRCASE SIGNAL

Characteristic	Performance Requirement	Supplemental Information
Luminance Component		
Step Amplitude		
10 Step	71.5 mV within 3%.	
5 Step	143 mV within 1%.	
Overall		714 mV within 1%.
Step Risetime	260 ns within 15%.	
Aberrations	Within 2% of step amplitude.	
Step Duration		
10 Step		
Blanking Level		13.2 μs within 5%.
White Level		9.9 μs within 5%.
Intermediate Levels		3.3 μs within 5%.

TABLE 1-1 (cont.)

Characteristic	Performance Requirement	Supplemental Information
5 Step		
Blanking Level		13.2 µs within 5%.
White Level		13.2 µs within 5%.
Intermediate Levels		6.6 µs within 5%.
Chrominance Component		
Amplitude	143 mV within 3%.	
Phase		180°
Differential Phase		
10%, 50%, and 90% APL		0.1° or less.
Differential Gain		
10%, 50%, and 90% APL		0.5% or less.
Subcarrier Envelope		
Risetime	400 ns within 15%.	
Duration	40 µs within 5%.	
Delay from Line Sync	16.1 µs within 5%.	
APL		APL specifications conform to IRE Standard 60-23S1.
Fixed		All active lines carry the modulated staircase signal with APL fixed at 50%.
Selectable	11 levels, equal within 2%.	Staircase signal is on every fifth line and the same line each frame. The IRE level of the other four lines can be selected from 0 IRE (10% APL) to 100 IRE (90% APL) in 10 equal increments.
Subcarrier Component		
OFF		No subcarrier.
UNMOD		30 mV within 5 mV (approximately 5 IRE units at 90°) during active line time of 52.3 µs.
MODULATED SUBCARRIER		30 mV within 5 mV for the first and last 13.2 µs of active line time. 286 mV within 3% (40 IRE) for the second 13.2 µs of active line time.
	572 mV within 3% (80 IRE) for the third 13.2 µs of active line time.	Phased at 90°.
	Incidental phase errors between 286 mV and 572 mV signals are 0.5° or less.	

TABLE 1-2
COLOR BAR

Characteristic	Performance Requirement	Supplemental Information
Timing EIA COLOR BARS Color Bars		181 lines field 1; 181.5 lines field 2.
Duration	7.5 μs per bar (7 bars).	
—I, W, Q, B		60.5 lines field 1; 60 lines field 2.
—I, W, Q, Duration	9.4 μs.	
B Duration	24.1 μs.	
FULL FIELD COLOR BARS		241.5 lines per field.
Duration	6.6 μs (8 bars).	
Risetime	115 ns within 15%.	
<u>COLOR BARS</u> Y REF		100% saturated bars first 181 active lines per field; 0% saturated bars last 60 lines per field.
Chrominance Time Difference between Luminance and Chrominance	20 ns or less.	
Risetime	400 ns within 15%.	
B—Y, R—Y Quadrature Error	0.5° or less.	
R—Y Axis Phase Switcher	0.5° or less.	
Residual Subcarrier	At least 52 dB below 1 volt on white and black.	
Aberrations		Within 4% peak to peak of 1 volt.
Spurious Subcarrier		At least 52 dB below 1 volt, when viewed on a Type 529, except 30 dB down at the end of H Blanking.
Other Spurious Outputs		At least 52 dB below 1 volt, when viewed on a Type 529, except 30 dB down during sync and at the end of H Blanking.
Luminance and Chrominance	Absolute amplitudes of luminance signal, setup, and sync are within 1% or 1.5 mV, whichever is greater, with respect to blanking.	
	Absolute amplitudes of all subcarrier frequency components (B—Y, R—Y) are within 3%.	
	With the red chrominance bar as an absolute reference, all other subcarrier frequency component amplitudes are within 1% or 1 mV plus the peak to peak residual subcarrier amplitude, whichever is greater, of their assigned values listed in Table 1-2.	
Blanking DC Level (With respect to ground)	0 volts within 50 mV.	

TABLE 1-2 (cont.)

Characteristic	Performance Requirement				Supplemental Information			
Reference Amplitudes (mV)	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)
Blanking Level	0	2.5 or less	- - - - -	- - - - -	*Same as color bar level as determined by Setup			
Sync	–285.7	2.5 or less	- - - - -	- - - - -				
Burst	0	285.7	285.7	0				
—I	*	285.7	155.6	239.6				
White Ref	714.3	2.5 or less	- - - - -	- - - - -				
Q	*	285.7	239.6	155.6				
Black	*	2.5 or less	- - - - -	- - - - -				
(75% Amplitude, 7.5% Setup)								
White	549.1	2.5 or less	- - - - -	- - - - -				
Yellow	494.6	445.1	434.7	95.6				
Cyan	400.4	625.9	146.5	608.5				
Green	345.9	588.3	288.2	512.9				
Magenta	256.7	588.3	288.2	512.9				
Red	202.2	625.9	146.5	608.5				
Blue	108.1	445.1	434.7	95.6				
Black	53.6	2.5 or less	- - - - -	- - - - -				
(75% Amplitude, 10% Setup)								
White					553.6	2.5 or less	- - - - -	- - - - -
Yellow					500.5	433.0	422.9	93.0
Cyan					408.9	609.0	142.6	592.1
Green					355.9	572.4	280.4	499.1
Magenta					269.1	572.4	280.4	499.1
Red					216.1	609.0	142.6	592.1
Blue					124.5	433.0	422.9	93.0
Black					71.4	2.5 or less	- - - - -	- - - - -
(75% Amplitude, 0% Setup)								
White					535.7	2.5 or less	- - - - -	- - - - -
Yellow					476.8	481.2	469.9	103.4
Cyan					375.0	676.7	158.4	657.9
Green					316.1	636.0	311.5	554.5
Magenta					219.6	636.0	311.5	554.5
Red					160.7	676.7	158.4	657.9
Blue					58.9	481.2	469.9	103.4
Black					0	2.5 or less	- - - - -	- - - - -

TABLE 1-2 (cont.)

Characteristic	Performance Requirement				Supplemental Information			
	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)	Lum	Chroma (P-P)	B—Y (P-P)	R—Y (P-P)
(100% Amplitude, 10% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					643.6	577.4	563.9	124.1
Cyan					521.4	812.0	190.1	789.5
Green					450.7	763.2	373.8	665.4
Magenta					335.0	763.2	373.8	665.4
Red					264.3	812.0	190.1	789.5
Blue					142.1	577.4	563.9	124.1
Black					71.4	2.5 or less	- - - - -	- - - - -
(100% Amplitude, 7.5% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					641.1	593.4	579.6	127.5
Cyan					516.1	834.6	195.4	811.4
Green					443.4	784.4	384.2	683.9
Magenta					324.5	784.4	384.2	683.9
Red					251.8	834.6	195.4	811.4
Blue					126.3	593.4	579.6	127.5
Black					53.6	2.5 or less	- - - - -	- - - - -
(100% Amplitude, 0% Setup)								
White					714.3	2.5 or less	- - - - -	- - - - -
Yellow					635.7	641.6	626.6	137.8
Cyan					500.0	902.3	211.2	877.2
Green					421.4	848.0	415.4	739.3
Magenta					292.9	848.0	415.4	739.3
Red					214.3	902.3	211.2	877.2
Blue					78.6	641.6	626.6	137.8
Black					0	2.5 or less	- - - - -	- - - - -

TABLE 1-3

COMP VIDEO

Characteristic	Performance Requirement	Supplemental Information
Outputs		Two
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Amplitude		1 volt into 75 ohms. (Refer to Reference Amplitudes)

[3] Return Loss measured with respect to 75 ohms.

TABLE 1-3 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Line Blanking		11.1 µs[4].
Field Blanking		21 lines[4].
Front Porch Duration (See Fig. 1-2)	1.54 µs, ± 50 ns.	
Line Sync (See Fig. 1-2)		
Duration	4.71 µs, ± 50 ns.	
Rise and Fall time	115 ns, ± 10%.	
Breezeway (See Fig. 1-2)	750 ns, ± 50 ns.	
Burst Envelope (See Fig. 1-2)		
Duration	2.31 µs, ± 70 ns, 8 cycle minimum.	
Rise and Fall time	400 ns, ± 15%.	
Amplitude	286 mV within 3%.	

TABLE 1-4

PULSE OUTPUTS

Characteristic	Performance Requirement	Supplemental Information
COMP SYNC		
Outputs		Two
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Return Loss[3]	At least 30 dB to 5 MHz.	
Isolation	At least 40 dB.	
Rise and Fall time (See Fig. 1-3)	115 ns within 10%.	
Jitter		4 ns peak to peak or less.
Line Sync (See Fig. 1-3)		
Duration	4.71 µs within 50 ns.	
Period		63.56 µs[4].
Equalizing Pulse (See Fig. 1-3)		
Duration	2.33 µs within 50 ns.	
Sequence		3 lines[4].

[3] **Return Loss measured with respect to 75 ohms.**

[4] **Digitally determined from 3.579545 MHz.**

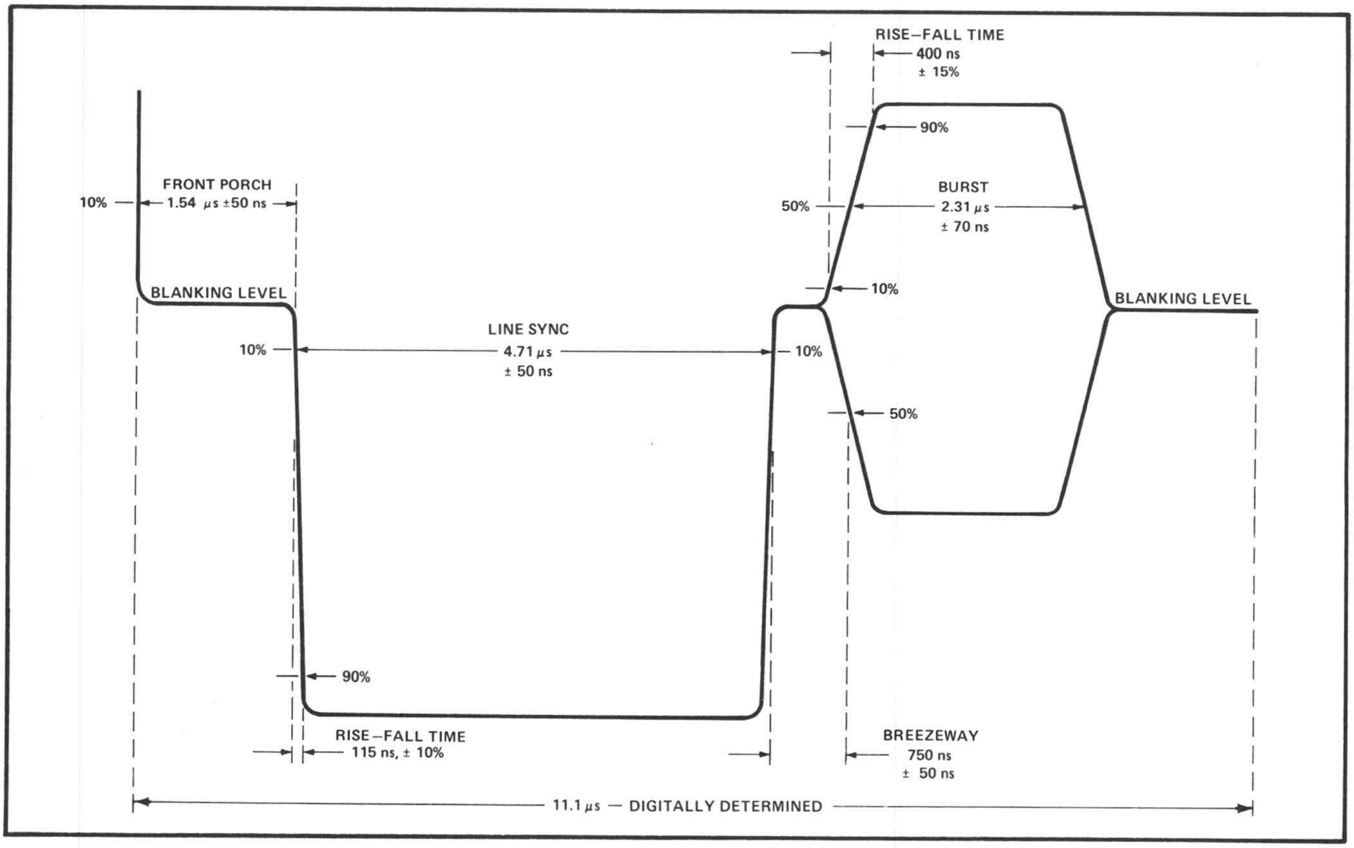


Fig. 1-2. Comp Video horizontal blanking details.

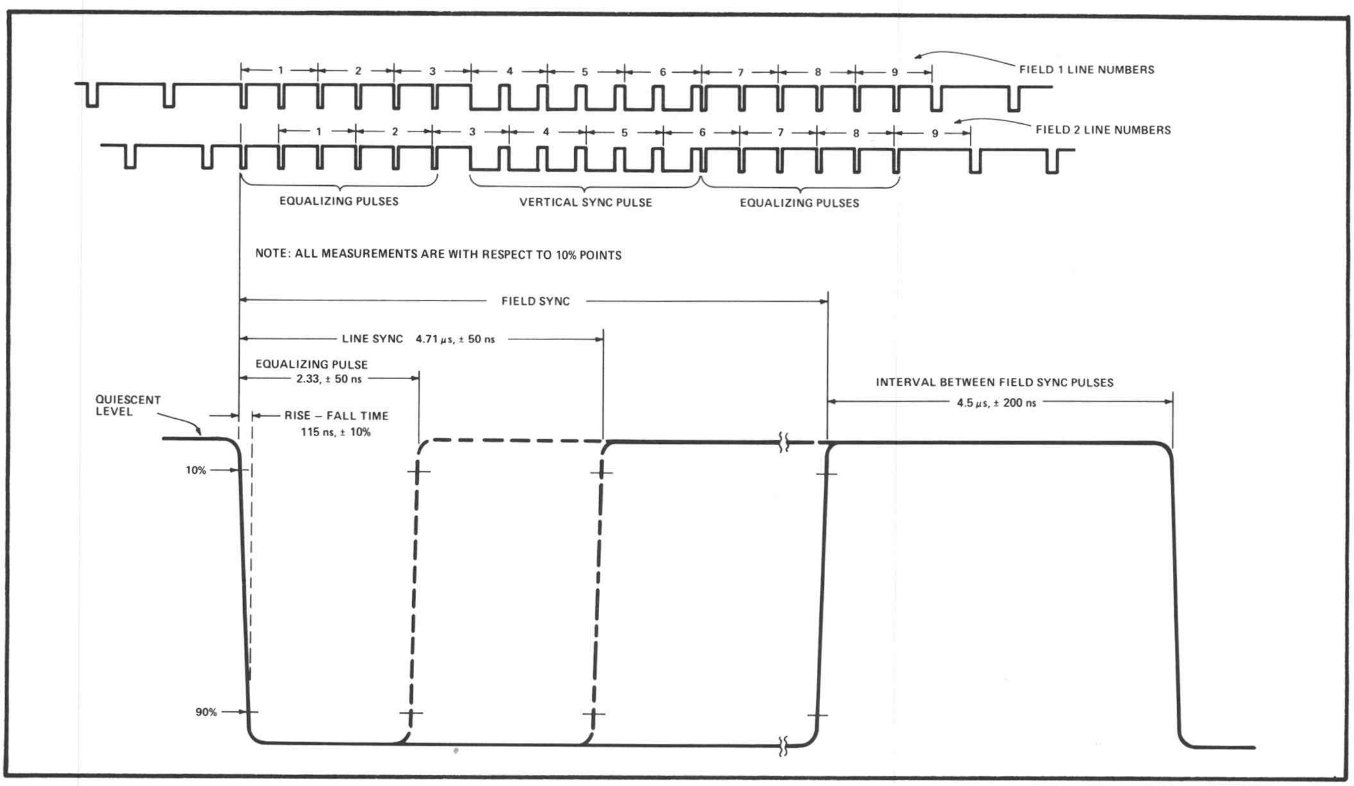


Fig. 1-3. Comp Sync blanking details.

TABLE 1-4 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Field Sync (See Fig. 1-3)		
Sequence		3 lines[4].
Interval Between	4.5 µs within 200 ns.	
Period		262.5 lines[4].
SUBCARRIER		
Outputs		Two
Amplitude	2 volts, within 0.2 volt, into 75 ohms.	
Frequency	3.579545 MHz within 5 Hz.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Input (Loop-Thru)		
Amplitude	1 volt to 4 volt.	
Return Loss[3]	At least 46 dB.	
HORIZ DRIVE		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Pulse Duration	6.35 µs within 5%.	
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
VERT DRIVE		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Pulse Duration		10.5 lines[4].
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
COMP BLANKING		
Outputs		Two
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Duration		
Line		11.1 µs[4]
Field		21 lines[4]
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	

[3] **Return Loss measured with respect to 75 ohms.**

[4] **Digitally determined from 3.579545 MHz.**

TABLE 1-4 (cont.)

Characteristic	Performance Requirement	Supplemental Information
BURST FLAG		
Amplitude	4 volts, within 0.2 volt, into 75 ohms.	
Duration	2.43 µs within 100 ns.	Measured at 10% from quiescent.
Rise and Fall time	115 ns within 10%.	
Return Loss[3]	At least 30 dB.	

TABLE 1-5

COLOR GEN LOCK

Characteristic	Performance Requirement	Supplemental Information
GEN LOCK Input		
Amplitude	1 V, ± 6 dB.	(Minimum 0.5 V to 2 V maximum.)
Sync Source		Composite video or "black burst" sync negative.
Input Configuration		Loop-thru
Return Loss[3]	At least 46 dB to 5 MHz.	
Burst/Sync Ratio	Within 6 dB.	
GEN LOCK Performance (Subcarrier)		
Phase Error		Within 1° with input burst variation of ± 10 Hz from 3.579545 MHz, nominal burst level.
With Temperature Variation (OVEN TEMP NORMAL Lamp On)		Within 5°, with ambient temperature variation from 0°C to 50°C; within 1° for any 10° increment within this range.
With Input Signal Variation		Within 1° with input signal variation of 3 dB from 1.0 V. Within 3° with variation of burst/sync ratio of −6 dB to +10 dB.
Breezeway Stability (See Fig. 1-2 for location of Breezeway)		0.2° or less for burst timing errors including burst width variance, 8–11 cycles, and breezeway variance ± 0.28 µs.
Dynamic Burst Phase Stability		0.1° or less with APL variation from 10% to 90%.
Phase Error Due to Noise		Within 1° with RMS white noise 24 dB below 714 mV, picture signal peak to peak.
CHROMA PHASE Control		Greater than 360°.
Loss of Burst Lock		Loss of lock indicated by front-panel lamp. Internal subcarrier free runs at 3.579545 MHz within 5 Hz. Subcarrier is not locked (phase) to Sync if external Sync is present.

[3] **Return Loss measured with respect to 75 ohms.**

[4] **Digitally determined from 3.579545 MHz.**

TABLE 1-5 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Loss of Sync		Loss of Sync indicated by front-panel lamp. Instrument returns instantly to internal color standard (burst loss indicator lamp also comes on).
GEN LOCK Performance (Sync)		
Delay Range	Adjustable so that output sync from 146 may be delayed from at least −3 µs to +1 µs.	Factory set to coincidence.
Delay Stability		Within 70 ns over the ambient temperature range of 0°C to 50°C.
Pull-In Time		200 ms (maximum).
Field/Frame Sync		Direct acting within 1 field. No time offset is provided.

TABLE 1-6

CONVERGENCE PATTERN

Characteristic	Performance Requirement	Supplemental Information
CONVERGENCE PATTERN		
Outputs		Two
Setup	7.5 IRE ± 1 IRE.	
Sync Amplitude	40 IRE, ± 2 IRE.	
Peak Level	77 IRE, ± 3 IRE.	
Return Loss[3]	At least 30 dB.	
Isolation	At least 40 dB.	
Risetime	115 ns within 10%.	
Crosshatch Vertical Lines		
Repetition Rate		315 kHz.
POSITION Range	At least 3.2 µs.	
Pulse Polarity		Positive
Unblanked Pulses	16 or 17. (Depends on POSITION control.)	
Pulse Duration		
Crosshatch	225 ns within 15%.	
Dot	350 ns within 15%.	

[3] Return Loss measured with respect to 75 ohms.

TABLE 1-6 (cont.)

Characteristic	Performance Requirement	Supplemental Information
Crosshatch Horizontal Lines		
Repetition Rate		900 Hz.[4]
POSITION Range		At least 1.1 ms.
Pulse Polarity		Positive
Unblanked		13 to 14. (Depends on POSITION control.)
Pulse Duration		
Crosshatch		1 line at field rate.[4]
Dot		3 lines per frame.[4]
Displays Available	Crosshatch	Formed by "OR" gating of horizontal and vertical crosshatch lines.
	Vertical Lines Only.	
	Horizontal Lines Only.	
	Dots	Formed by "AND" gating of vertical and horizontal dot-forming lines.
	Crosshatch plus Dots.	Dots appear centered in rectangles formed by the crosshatch pattern.

TABLE 1-7

POWER SUPPLY

Characteristic	Performance Requirement	Supplemental Information
Line Voltage Range		
115 VAC Low		90 V to 110 V.
115 VAC Medium		104 V to 126 V.
115 VAC High		112 V to 136 V.
230 VAC Low		180 V to 220 V.
230 VAC Medium		208 V to 252 V.
230 VAC High		224 V to 272 V.
Crest Factor		At least 1.35.
Line Current		0.5 A (maximum).
Power		65 W (maximum).
Line Frequency Range		48 Hz to 66 Hz.

[4] **Digitally determined from 3.579545 MHz.**

TABLE 1-8

PHYSICAL

Characteristic	Information	
Finish	Cabinet is blue-vinyl paint. Front panel is anodized aluminimum.	
Dimensions (Approximate)	Rackmount Version	Bench Version
Height	3 1/2 inches (overall)	3 1/2 inches (cabinet)
Width	19 inches (overall)	17 inches (cabinet)
Length	19 3/4 inches (overall)	19 inches (overall)
Length	18 1/2 inches (cabinet)	18 1/2 inches (cabinet)
Width	17 inches (cabinet) 17 1/2 inches (over sides)	18 inches (overall)
Height	- - - - - - - - - - - - - - -	3 3/4 inches (overall)
Weight (Approximate)	18 1/2 pounds	17 3/4 pounds

ENVIRONMENTAL CHARACTERISTICS

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirements given in this section following an environmental test. Complete details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

TABLE 1-9

ENVIRONMENTAL

Characteristic	Information
Temperature	
Non-Operating Range	−40°C to +65°C.
Operating Range	0°C to +50°C.
Altitude	
Non-Operating Range	To 50,000 feet.
Operating Range	To 15,000 feet.

ACCESSORIES

Standard accessories supplied with this instrument can be found on the last page of the Mechanical Parts List illustrations. For additional accessories, see the current Tektronix, Inc. catalog.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of this manual.

INSTALLATION

Rackmounting

Complete information for mounting the 146 in a rack is given in Section 7.

Operating Voltage

The 146 may be operated from either 115-VAC or 230-VAC (nominal) line voltage source. Quick-change line-voltage selector plugs, located under the fuse cover on the rear panel, change the transformer primary connections so the instrument will operate from one line voltage or the other (115 V or 230 V). In addition, the plugs permit one of three line voltage operating ranges to be selected. Table 2-1 lists the voltage ranges that enable the instrument DC power supplies to regulate properly.

To convert to a different line voltage, proceed as follows:

1. Disconnect the 146 from the power source.

TABLE 2-1

115/230 Voltage Selector Plug Position	Range Selector Plug Position	Nominal Line (center) Voltage	Line Voltage Plug Range[1]
115 V	LO (Low)	100 VAC	90 to 110 VAC
	M (Medium)	115 VAC	104 to 126 VAC
	HI (High)	124 VAC	112 to 136 VAC
230 V	LO (Low)	200 VAC	180 to 220 VAC
	M (Medium)	230 VAC	208 to 252 VAC
	HI (High)	248 VAC	224 to 272 VAC

[1] **Applicable when the line contains less than 2% total distortion.**

2. Unscrew the two captive screws holding the fuse cover. Remove the cover and attached fuses.

3. To convert to a different line voltage (115 V to 230 V), pull out the 115/230 Voltage Selector plug (see Fig. 2-1) then rotate the plug 180° and insert it into the opposite set of holes. The 115/230 Voltage Selector plug is located in the upper position for 115-V operation and in the lower position for 230-V operation.

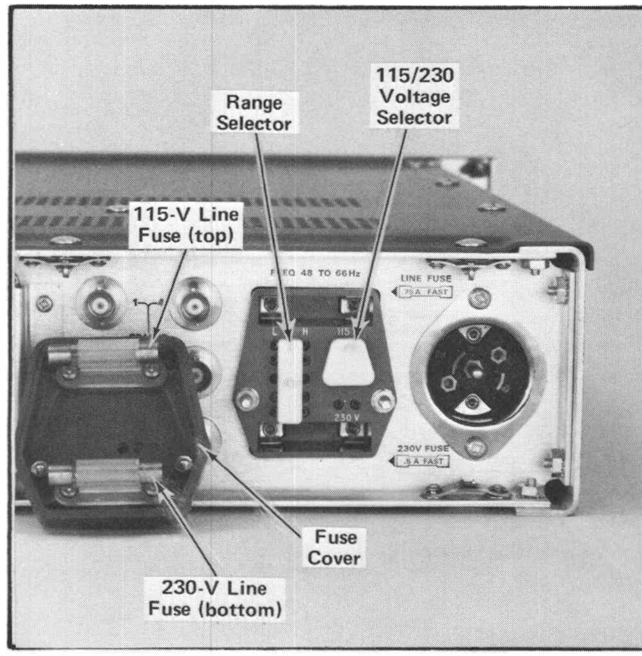


Fig. 2-1. Location of Range and Voltage Selector plugs with fuse cover removed. The plugs as shown are set for 115-V medium range operation.

4. To change the line-voltage operating range (LO, M or HI), pull out the Range Selector plug (see Fig. 2-1) and insert it in the desired hole locations. Select a range with a center voltage (see column 3 in Table 2-1) closely corresponding to the line voltage that will be applied in regular instrument operation.

5. Re-install the cover with two captive screws and fuses. Be sure the cover fits firmly against the rear panel. This indicates that the line fuses are seated properly in the fuse clips.

6. Before applying power to the instrument, check that the indicating tabs on the selector plugs protrude through the proper holes in the cover for the correct line voltage and the proper operating range.

CAUTION

The 146 should not be operated with the 115/230 Voltage Selector and/or Range Selector plugs in the wrong position for the line voltage applied.

BASIC INFORMATION

Frequent check-out of color broadcast equipment is essential in providing realistic and accurate presentation of taped or live color scenes. In addition, rapid check-out of the signal monitoring instrument is highly desirable.

The 146 provides a high-quality composite video signal, complete with color components, suitable for checking calibration and operation of vectorscopes and TV waveform monitors.

The various components which comprise the composite color video signal can be added or removed from the composite signal by selecting appropriate positions of the front-panel controls of the 146. This permits the simulation of various broadcast equipment troubles, such as loss of sync signals, B—Y or R—Y components, etc.

The 146 also serves as an excellent teaching aid, since the composite video signal can be "built up", one component at a time. Also, both the familiar staircase and color bar test signals are available as part of the composite video signal.

Fig. 2-2 illustrates the 146 COLOR BARS FIELD DISPLAY signals that are available. These signals are useful for checking luminance, hue, and saturation levels.

Luminance, or brightness as perceived by the eye, is represented by the amplitudes of the step levels of the color bar signal between black and white levels. Since the eye is more sensitive to green, and less to blue light of equal energy, green is a bright color, blue is a dark color as conveyed by the luminance signal to monochrome TV receivers. The color bar steps are therefore arranged in descending luminance order starting with yellow, the brightest color, and ending with blue, the least bright color.

Chrominance consists of two additional quantities; hue and saturation. Hue is the attribute of color perception that determines whether the color is red, blue, green, or some other color. White, black and gray are not considered hues. In color TV systems, the hue is encoded as a phase angle of the signal with respect to a reference frequency (burst signal). See Fig. 2-3A.

Saturation is the degree to which a color (or hue) is diluted by white light. Percentage of saturation is used to distinguish between vivid and weak shades of the same hue. For example; vivid red is highly saturated while pink or pastel red has little saturation. One-hundred percent saturation represents full hue with no white dilution (see Fig. 2-3B). In a vector display, saturation is indicated by the length of the vector.

Fig. 2-4 illustrates the MOD STAIRCASE signals that are available. Each is modulated by the subcarrier (3.579545 MHz). The steps are equally spaced between black level and white level. Staircase signals are useful for checking the presence of non-linearity in video stages. Typical tests made with a modulated staircase are differential gain and differential phase.

Differential gain is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, presence of differential gain causes distortion of the saturation in areas between the light and dark portions of the screen.

Differential phase is phase modulation of the chrominance signal by the luminance signal. With differential phase present, color (hue) will vary with scene brightness in the reproduced color picture.

CONTROLS AND CONNECTORS

Introduction

The following describes the function or operation of the 146 controls and output connectors (see Fig. 2-5).

Front-Panel Controls and Selectors

COLOR BARS — Seven lever switches that select signal elements which make up the color bar test signals.

R—Y Switch: Up position turns on the R-Y (90°-270° axis) component of the color bar test signal, down position turns off the R—Y component.

B—Y Switch: Up position turns on the B—Y (0°-180° axis) component of colorbar test signal, down position turns off the B—Y component.

Y Switch: Up position turns on the luminance component of the color bar. Down position turns off the component.

AMPL Switch: Sets the amplitude of the color bar signal at 75% or 100% maximum amplitude.

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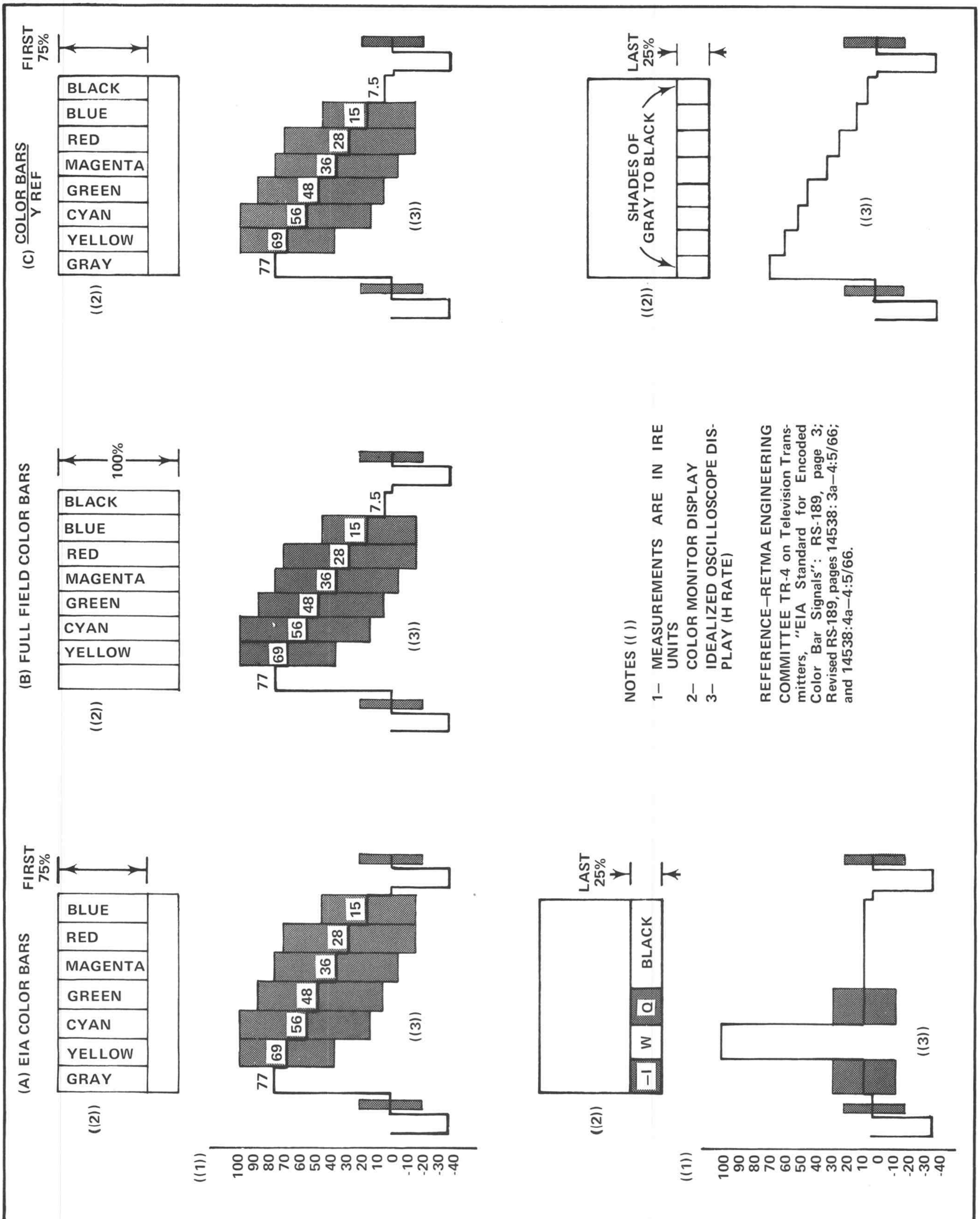
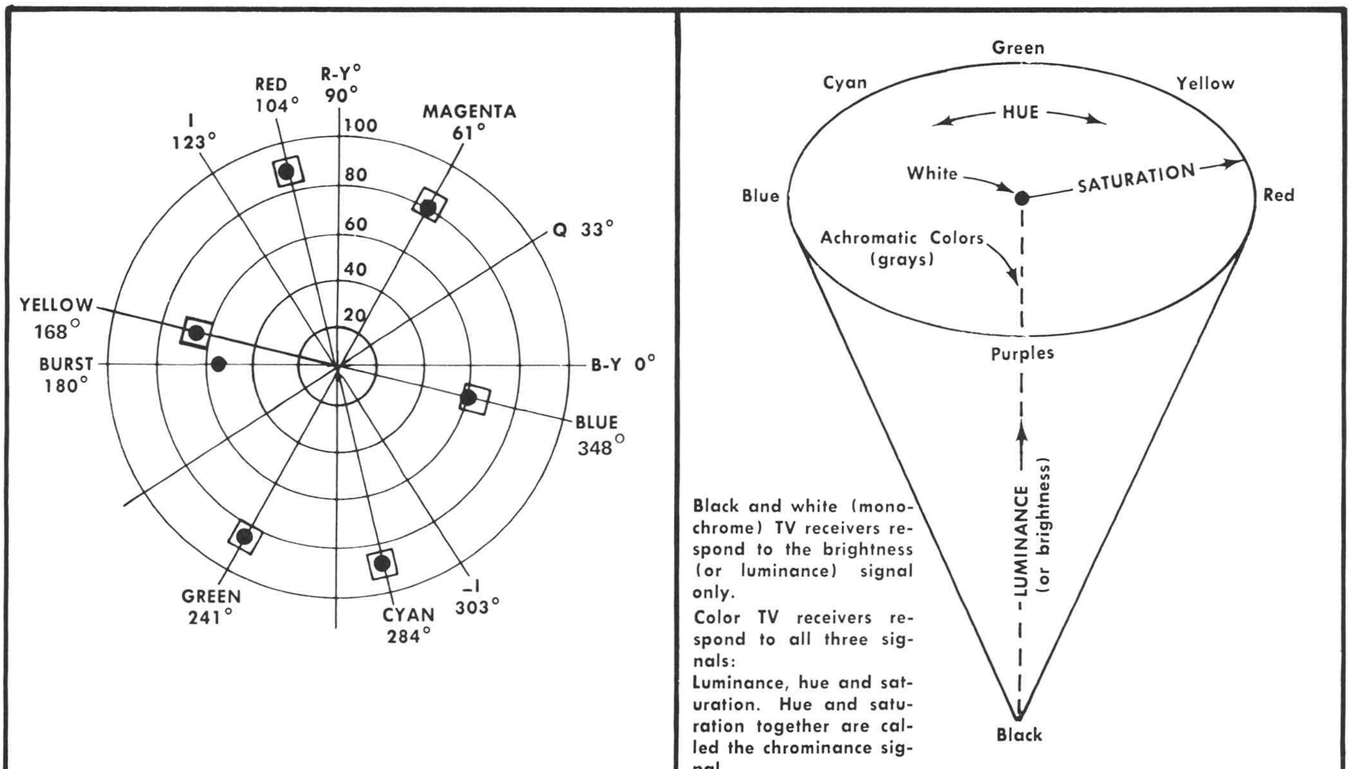


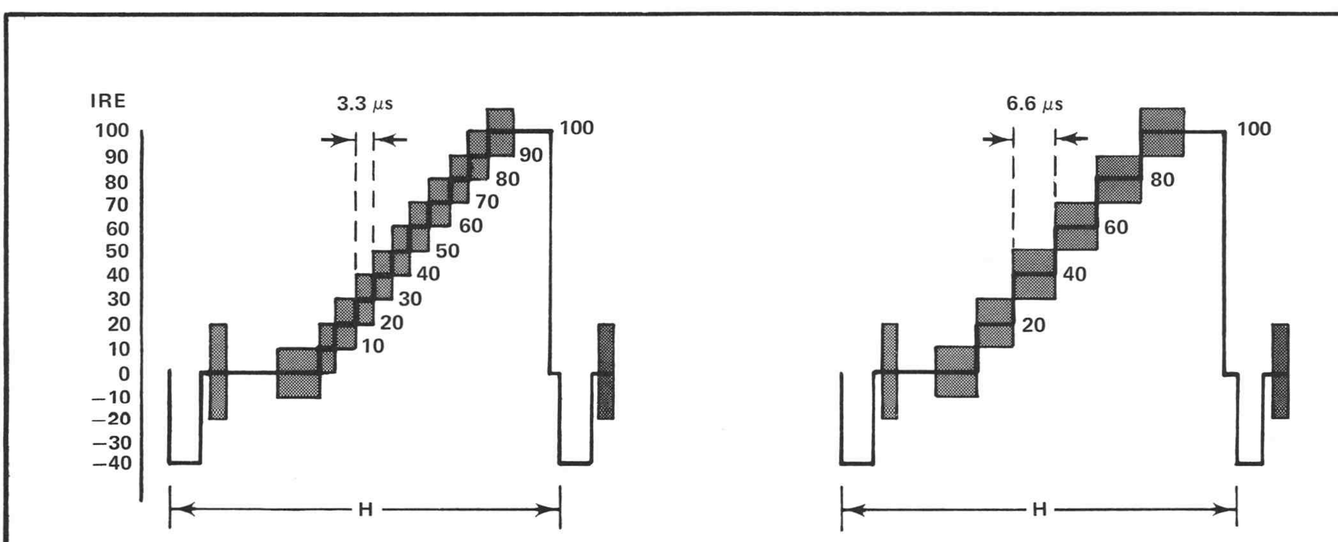
Fig. 2-2. Idealized illustrations with notes showing characteristics of the three COLOR BARS FIELD DISPLAY test signals.



(A) Standard color-phase vector diagram showing vector relationship among chrominance components.

(B) Conical three-dimensional representation of color concepts.

Fig. 2-3. Illustrations showing the relationship between the basic color concepts and the standard color-phase vector diagram.



(A) Ten Step Staircase

(B) Five Step Staircase

Fig. 2-4. Idealized oscilloscope display showing characteristics of the 146 MOD STAIRCASE signal displays.

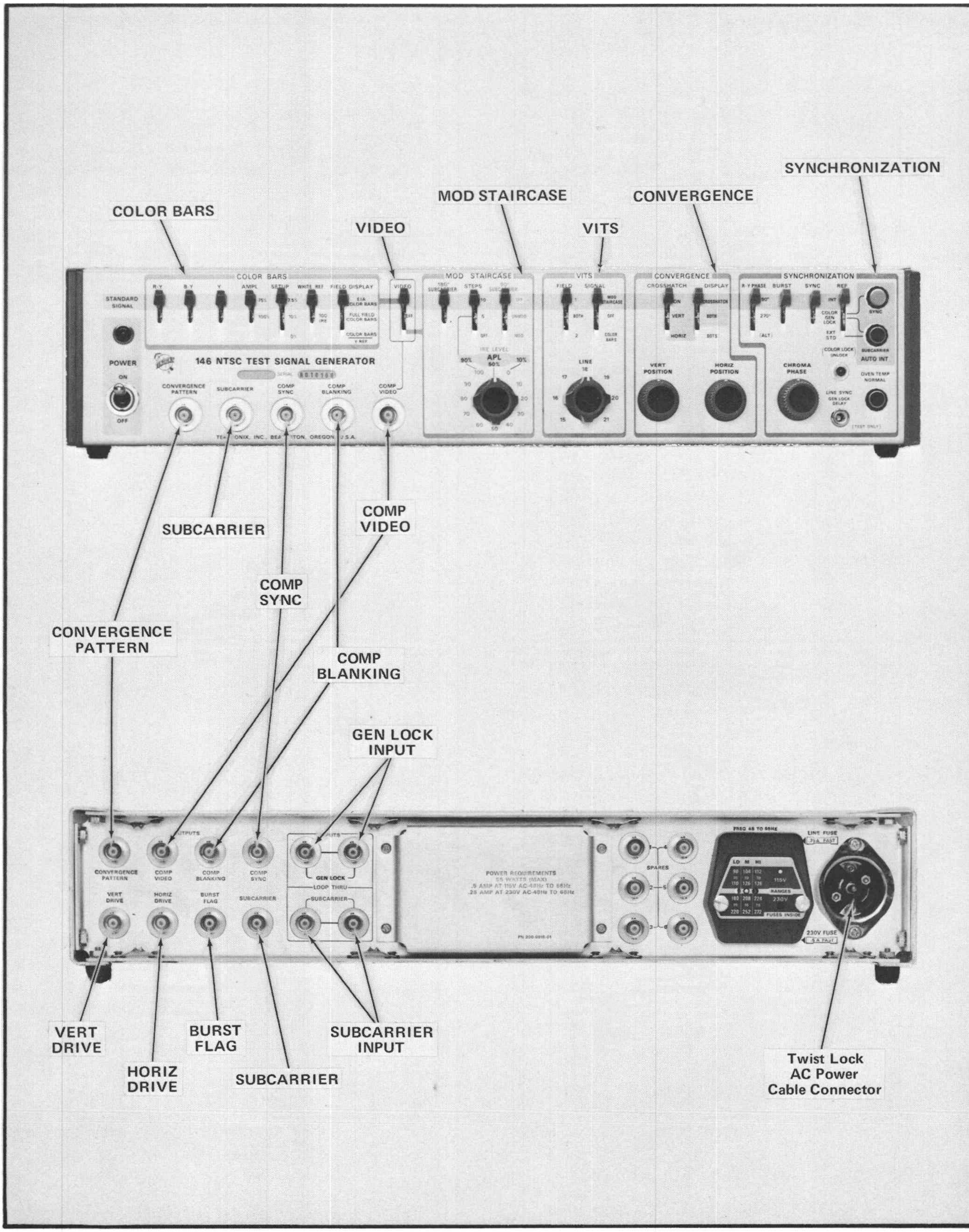


Fig. 2-5. Front- and rear-panel controls and connectors on the 146.

COLOR BARS (cont)

SETUP Switch: The 7.5% position provides a setup of 7.5% of the 100% white reference level. The 10% position sets the black level at 10% of the 100% white reference level. The 0% position removes the setup. In this position (0%) the black level is the same as the blanking level.

WHITE REF Switch: Affects white bar of FULL FIELD COLOR BARS and COLOR BARS/Y REF only. Up position allows white bar amplitude to be selected by the AMPL and SETUP switches. The 100 IRE position sets the white reference at 100% amplitude.

FIELD DISPLAY Switch: The EIA COLOR BAR position puts the split field display signal on both fields (see Fig. 2-2A). In FULL FIELD COLOR BARS position the entire display consists of the color bar signal (see Fig. 2-2B). In the COLOR BARS/Y REF position the upper 3/4 of the display contains the color bars and the lower 1/4 contains the luminance levels of the color bar signal (see Fig. 2-2C).

VIDEO

Up position of the selector provides a color bar signal at the COMP VIDEO connector. Center (OFF) position removes the video component from all the active video lines (Sync, Burst, and VITS remain). Down position of the selector provides a staircase signal at the COMP VIDEO connectors.

MOD STAIRCASE

Consists of three lever switches and a twelve-position rotary switch that select the individual components of the staircase test signal.

180° SUBCARRIER Switch: Up position applies subcarrier phased 180° to the staircase test signal. Down position of the switch removes the subcarrier.

STEPS Switch: Up position provides 10 step staircase at the COMP VIDEO output. Center position provides 5 step staircase. Down position removes the staircase.

90° SUBCARRIER Switch: The 90° subcarrier applies to 4 out of 5 lines when the APL/IRE LEVEL rotary switch is in the 0 to 100 positions or to every line when the 180° SUBCARRIER and STEPS switches are both down.

The OFF position provides no subcarrier. The UNMOD position provides a 30 mV, 90° subcarrier with no amplitude or phase modulation. The MOD position provides a 30 mV, 90° subcarrier for the first and last 13.2 μs of each active line, a 305 mV, 90° subcarrier for the second 13.2 μs, and a 610 mV, 90° subcarrier for the third 13.2 μs.

APL/IRE LEVEL Rotary Switch: The 50% position provides a staircase signal on each active video line. The 0 to 100 positions provide a staircase signal to one out of every five active video lines and a selectable luminance level on the remaining four. The 90° subcarrier can be applied to four of five lines (with both the 180° SUBCARRIER and STEPS switches down, the APL is applied to every line including VITS STAIRCASE).

VITS

Two three-position lever switches and a seven-position rotary switch that select the line and field to which the vertical interval test signal is applied. Either color bar, APL, or staircase signal is available.

LINE Rotary Switch: Selects any line from line 15 through line 21 to which VITS is applied.

FIELD Switch: Selects field one, field two, or both fields to which the VITS is applied.

SIGNAL Switch: MOD STAIRCASE position provides a VITS consisting of either a 10 step (11

VITS (cont)

level) or a five step (six level) modulated staircase which can be modified by the settings of the 180° SUBCARRIER and STEPS lever switches. When the 180° SUBCARRIER and the STEPS switches are down, an APL signal is applied to the VITS, the VITS can be modified with the 90° SUBCARRIER switch and APL/IRE LEVEL rotary switch.

The OFF position removes the VITS. The COLOR BAR position provides VITS consisting of a standard NTSC color bar signal which can be modified by the COLOR BARS lever switches (except the FIELD DISPLAY switch).

CONVERGENCE

Two lever switches and two potentiometers that control and position the display. The convergence signal is available at the CONVERGENCE PATTERN connectors.

CROSSHATCH Switch: ON position provides a crosshatch display. (DISPLAY switch must be in CROSSHATCH or BOTH positions.) VERT position provides vertical white bars only. HORIZ position provides horizontal white bars only.

DISPLAY Switch: The CROSSHATCH position provides a crosshatch display which can be modified by the CROSSHATCH switch selections. The BOTH position provides white dots centered in the rectangles formed by crosshatch. The DOT position provides white dots only.

VERT POSITION Control: Positions the display vertically.

HORIZ POSITION Control: Positions the display horizontally.

SYNCHRONIZATION

Consists of four lever switches, a goniometer to control synchronization of signals, screwdriver adjustment for internal-external timing, and a pushbutton switch to free run the generator.

R—Y PHASE Switch: 90° position, R—Y axis is locked to 90°. (Normal NTSC operation). 270° position, R—Y axis is locked to 270°. (For tests only). ALT position, R—Y axis alternates between 90° and 270° at H rate. (For testing quadrature phasing only).

BURST Switch: Applies (up position) or removes (down position) burst to COMP VIDEO outputs.

SYNC Switch: Applies or removes horizontal and vertical sync pulses to composite video output.

REF Switch: Up position (INT) selects internal sync generator and color standard. The center position (COLOR GEN LOCK) selects externally applied composite video or "Black Burst" to synchronize all signals. The down position (EXT STD) selects an externally applied color standard for the color standard.

(COLOR LOCK UNLOCK) Switch: Momentary type pushbutton switch, that produces loss of locking of horizontal sync to color subcarrier, when depressed, for test purposes.

CHROMA PHASE Control: Goniometer that varies burst phase of composite video output 360° in relation to subcarrier (either internal or external).

LINE SYNC GEN LOCK DELAY Control: Screwdriver adjustment to allow timing between 146 and external timing source.

POWER

Switches power ON and OFF.

Light: Indicates when POWER switch is on and the instrument is connected to a line voltage source.

OVEN TEMP NORMAL LIGHT	Indicates when lighted, that the Master Oscillator crystal oven is at normal operating temperature.
AUTO INT SYNC LIGHT	An amber light that indicates when lit that external Sync is absent and Sync is generated by the internal Generator.

NOTE

Burst loss light also lights. See Operating Options, this section, for exceptions.

AUTO INT SUB-CARRIER LIGHT	A red light that indicates, when lit, that external subcarrier standard has been lost.

NOTE

See Operating Options, this section, for exceptions.

Output Connectors

All output signals are via BNC type connectors and have a 75 ohm source impedance. For proper operation, each output, when in use must drive a 75 ohm load.

CONVERGENCE PATTERN (Front and rear panel)	Provides a 835.5 mV P-P composite video signal, consisting of composite sync and convergence pattern signals as selected by front-panel controls.
SUBCARRIER (Front and rear panel)	Provides a 2 V P-P sine wave output at subcarrier frequency (3.579545 MHz).
COMP SYNC (Front and rear panel)	Provides a 4 V negative-going composite sync pulse per EIA specifications.
COMP BLANKING (Front and rear panel)	Provides a 4 V negative-going composite blanking pulse per EIA specifications.
COMP VIDEO (Front and rear panel)	Provides 1 V P-P composite video signal consisting of composite sync and video test signals as selected by front-panel controls (except CONVERGENCE controls).
BURST FLAG (Rear panel)	Provides 4 V negative-going pulses with leading edge 400 ns prior to burst. (Measured at 10% from quiescent on flag to 50% point on burst envelope.)
HORIZ DRIVE (Rear panel)	Provides a 4 V negative-going pulse. Its leading edge is coincident with the start of line blanking.
VERT DRIVE (Rear panel)	Provides a 4 V negative-going pulse. Its leading edge is coincident with the start of vertical blanking.

Input Connectors

All input signals are via BNC type connectors and are Loop-Thru. For proper operation each input, when in use, must be terminated into 75 ohms.

SUBCARRIER (Rear panel)	Accepts a 3.579545 MHz signal, 1 to 4 volts in amplitude.
GEN-LOCK (Rear panel)	Accepts composite video or "Black Burst" 0.5 volt to 2 volts in amplitude.

FIRST-TIME OPERATION

The following procedure demonstrates the use of the controls and connectors in the 146. Operation with three different display instruments is outlined for the convenience of the user. It is assumed that a video waveform monitor is available. A Vectorscope is essential if phase characteristics of the composite video output are to be observed. An oscilloscope is useful for observing sync, drive, and other output signals. It may be used to display all outputs except for phase characteristics.

To provide external composite video and color standard signals, a generator meeting all the input specifications of the 146 must be used.

Procedure 1

A Type R529 Waveform Monitor is used to display the following:

1. Check the position of the line voltage selector plugs. (See Installation, this section.) Connect the 146 to the power source and turn on the POWER switch.

2. From the 146 COMP VIDEO connector, connect a 75 ohm coaxial cable to the Type R529 Video Input A connector. Connect a 75 ohm end-line termination to the other A Input connector.

3. While the instrument is warming up (OVEN TEMP NORMAL Light on when ready), set the front-panel controls as follows:

146

Set all switches to the STANDARD SIGNAL POSITION (all up).

Type R529

Vertical:	
Input	A
DC Restorer	On
Response	Flat
Volts Full Scale	1.0 (calib)
Position	Centered
Calibrator	Full Scale
Focus	Sharp Trace
Intensity	As desired
Scale Illum	Fully CW
Horizontal:	
Position	Centered
Display	2 line
Mag	X1
Line Selector	18
Field	One
Sync	Int

4. The display should consist of two lines of composite video, each containing the EIA Color Bar test signal similar to that shown in Fig. 2-2A.

5. With the Type R529 Vertical Position control, set the blanking level on the 0 IRE graticule line. The sync tips should be at −40 IRE, the white level should be at 77 IRE, the white level of the −I, W, Q, B signal should be at 100 IRE, and the black level of the −I, W, Q, B signal should be at the 7.5 IRE level.

6. Set the COLOR BARS R−Y and B−Y switches down. Note the display now shows only the luminance component of the color bar signal (the luminance levels should correspond to these given in Fig. 2-2A) and the entire −I, W, Q, B signal. Return the R−Y and B−Y switches to the up position.

7. Set the COLOR BARS Y switch down. Note: the display now consists of the complete −I, W, Q, B signal but only the chrominance portion of the color bar signal is present. Return the Y switch to the up position.

8. Set the COLOR BARS AMPL switch to 100%. Note the change in amplitude of the color bar white reference and chrominance amplitudes. Also, note there is no change in the −I, W, Q, B signal. Return the AMPL switch to 75%.

9. Set the COLOR BARS SETUP switch to 10%. Note: the entire composite video signal has shifted upward. The black level of the −I, W, Q, B signal should be at 10 IRE. Now, set the SETUP switch to 0%. Note: the entire composite video signal has shifted down. The black level of the −I, W, Q, B signal should be at 0 IRE. Return the SETUP switch to 7.5%.

10. Set the COLOR BARS WHITE REF switch to 100 IRE. Note the display does not change. Return the WHITE REF switch to the up position.

11. Set the COLOR BARS FIELD DISPLAY switch to FULL FIELD COLOR BARS. Note: the display now contains a composite video signal without the −I, W, Q, B signal. Also, note that the width of the chrominance bars have decreased. This signal should be similar to that shown in Fig. 2-2B.

12. Set the COLOR BARS WHITE REF switch to 100 IRE. Note the white pulse is now at 100 IRE. Return the WHITE REF switch to the up position.

NOTE

The COLOR BARS R−Y, B−Y, Y, AMPL, and SETUP switches operate in a manner identical to their operation with EIA COLOR BARS.

13. Set the COLOR BARS FIELD DISPLAY switch to COLOR BARS/Y REF. Note: the display now contains a composite video signal without the −I, W, Q, B signal but has a luminance display. This signal should be similar to that shown in Fig. 2-2C. Return the FIELD DISPLAY switch to EIA COLOR BARS.

14. Set the Type R529 Display switch to 2 Field. Note: the field is split to include a color bar signal for the first

11.5 ms and a −I, W, Q, B signal for the next 3.8 ms. Set the 146 COLOR BARS FIELD DISPLAY switch to FULL FIELD COLOR BARS and note that the entire field is color bars. Set the FIELD DISPLAY switch to COLOR BARS/Y REF and note that the field is split to include a color bar signal for the first 11.5 ms and a color bar luminance signal for the next 3.8 ms. Return the FIELD DISPLAY switch to FULL FIELD COLOR BARS position, and the Type R529 Display switch to 2 line.

15. Set the 146 VIDEO switch to OFF. The display should consist of only sync and burst ("Black Burst"). Set the VIDEO switch to the down position. The signal can now be altered with the controls in the MOD STAIRCASE section. The display should consist of a modulated staircase signal similar to that shown in Fig. 2-4A.

16. Set the MOD STAIRCASE 180° SUBCARRIER switch to the down position. Notice that the modulation on each of the steps has been removed, leaving only a luminance level for each step. Return the 180° SUBCARRIER switch to the up position.

17. Set the STEPS switch to 5. This display should consist of a modulated staircase signal similar to Fig. 2-4B. Set the STEPS switch to OFF. This removes the steps leaving only the modulation. The modulation may be removed with the 180° SUBCARRIER switch.

18. Set the MOD STAIRCASE 180° SUBCARRIER switch to its down position, 90° SUBCARRIER switch to UNMOD and the APL/IRE LEVEL switch to 0. Note the APL offset chroma on each line.

19. Set the 90° SUBCARRIER switch to MOD. This applies modulation to the APL offset chroma. The APL level may be changed from 0 to 100 with the APL/IRE LEVEL switch. Return the APL/IRE LEVEL switch to 0.

20. Set the Type R529 Display switch to 2 Field and the Mag switch to X25. Set the 146 MOD STAIRCASE STEPS switch to 5 and note that a staircase signal now appears on one out of every five lines in the active video region including VITS. Modulation can be applied to the steps with the 180° SUBCARRIER switch (see Fig. 2-6). Return the 180° and 90° SUBCARRIER switches to the Standard Signal position and the APL/IRE LEVEL switch to 50%.

21. Adjust the Type R529 Horizontal Position control to display the field blanking interval. Set the 146 VIDEO switch to the up position and note the VITS staircase signal on line 18 (see Fig. 2-7). The VITS signal may be put on different lines with the VITS LINE selector. The staircase may be changed to an APL signal by changing the 180° SUBCARRIER and STEPS switches to the down position and rotating the APL/IRE LEVEL switch (modulation can be applied with the 90° SUBCARRIER switch) or to a color bar signal with the VITS SIGNAL switch. The signal may be removed completely with the same switch by placing it in the OFF position.

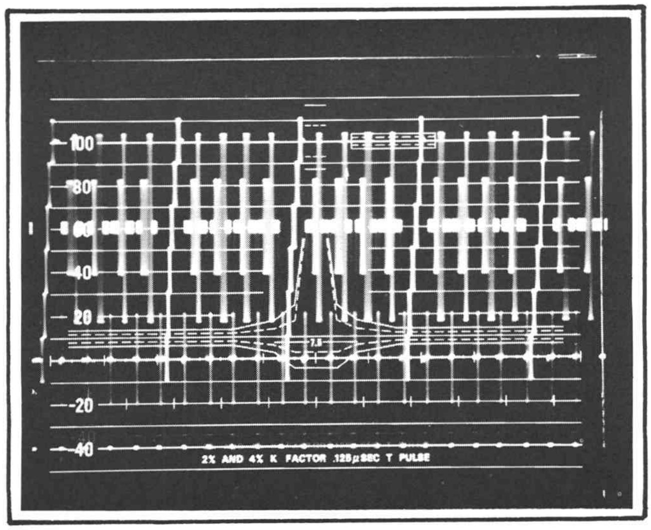


Fig. 2-6. Modulated 60 IRE level with modulated steps.

22. Set the Type R529 Mag switch to X1. Switch the VITS FIELD selector from 1 to BOTH and change the VITS SIGNAL selector to MOD STAIRCASE. Note the VITS staircase appears on both fields. Now change the VITS FIELD switch from BOTH to 2 and note that the staircase appears on only field 2.

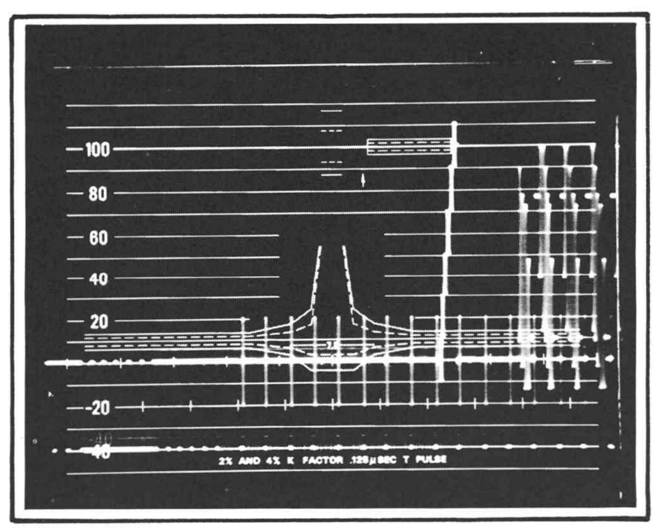


Fig. 2-7. Field blanking interval showing the VITS on line 18.

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23. Set the Type R529 Display selector to 2 Line and the DC Restorer switch to Off. Set the 146 SYNCHRONIZATION BURST switch to the down position and note that burst is removed from the composite video signal. Return the BURST switch to the up position.

24. Set the SYNCHRONIZATION SYNC switch to the down position and note that the sync has been removed from the display. Return the SYNC switch to the up position.

25. Observing the 146 front-panel, set the REF switch to COLOR GEN LOCK. Note both the amber (sync loss indicator) and red (subcarrier loss indicator) lights are on, and the display consists of Comp Sync only.

26. Set the REF switch to EXT STD. Note: only the red indicator is on and the display consists of Comp Sync and Luminance only. Return the REF switch to the INT position.

Procedure 2

A Type 547 Oscilloscope with a Type 1A1 Plug-In Unit is used as a display device for the following procedure. The oscilloscope must have a bandwidth from DC to approximately 5 MHz. An oscilloscope with a bandwidth of DC to 15 MHz or greater and a deflection factor of 0.1 V/Cm or better is recommended.

1. From the external signal source (A Type 140 was used for this procedure), connect composite video via a 75 ohm coaxial cable to the 146 rear-panel GEN LOCK Loop-Thru Input connector. Terminate the unused connector with a 75 ohm end-line termination. Connect subcarrier via a 75 ohm coaxial cable to the 146 rear-panel SUBCARRIER Loop-Thru Input connector. Terminate the unused connector with a 75 ohm end-line termination.

2. From the 146 COMP VIDEO connector, connect a 75 ohm coaxial cable and a 75 ohm termination to the Channel 1 Input connector of the Type 1A1. From the 146 rear-panel HORIZ DRIVE connector, connect a 75 ohm coaxial cable to the test oscilloscope Time Base A Trigger Input connector.

3. Set the 146 front-panel switches to the STANDARD SIGNAL position.

4. Set the test oscilloscope for minus external DC triggering at a sweep rate of 10 μs. Set the Type 1A1 for DC coupling at .2 V/Cm.

5. Perform steps 4 through 13 of Procedure 1.

NOTE

The displays obtained will be the same as those obtained with the Type R529, except there is no IRE scale on the graticule and the display will consist of approximately 1.5 TV lines.

6. Change the 75 ohm coaxial cable on the 146 rear-panel HORIZ DRIVE connector to the VERT DRIVE connector. Change the test oscilloscope Time/Cm to 5 ms, then do step 14 of procedure 1.

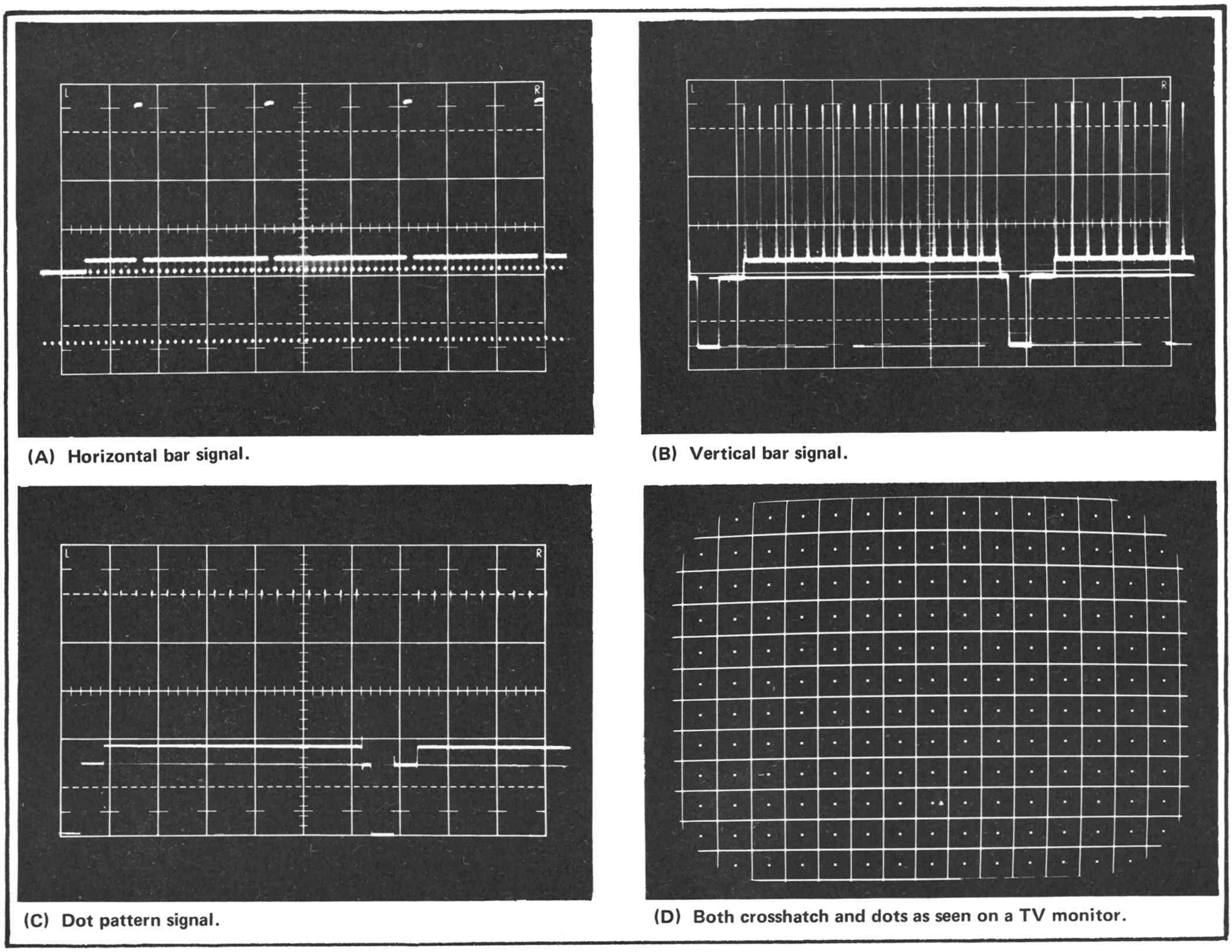
7. Change the 75 ohm coaxial cable on the 146 VERT DRIVE connector to the HORIZ DRIVE connector. Change the test oscilloscope Time/Cm to 10 μs, then do steps 15 thru 19 of procedure 1.

8. Set the 146 MOD STAIRCASE STEPS and 180° SUBCARRIER switches to the up positions. Change the test oscilloscope for internal triggering and the Time/Cm to .1 ms. Adjust the Trigger Level control to obtain a stable display. The display should now show one line out of every five with staircase signal and the other four with modulated 90° subcarrier.

9. Change the cable from the 146 rear-panel HORIZ DRIVE connector to the VERT DRIVE connector, then change the test oscilloscope for external triggering and the Time/Cm to .2 ms. The display should now show the vertical blanking interval. Set the 146 VIDEO switch to the up position. Note the VITS staircase on one of the lines. Rotate the VITS LINE selector on the 146 and note that the VITS signal appears on different lines as the selector is rotated.

10. Set the STEPS and 180° SUBCARRIER switches down. Rotate the APL/IRE LEVEL switch. Note the change in the IRE level of the VITS signal. Modulation can be added to the IRE level with the 90° SUBCARRIER switch. Set the VITS SIGNAL switch to OFF. Note that the VITS staircase has been removed. Set the SIGNAL switch to COLOR BAR. Note: the VITS signal is now a color bar.

11. Change the cable from the 146 COMP VIDEO connector to the CONVERGENCE PATTERN connector. Set the CONVERGENCE CROSSHATCH switch to HORIZ. Set the test oscilloscope Time/Cm to 2 ms with X5 magnification. Note the single line out of every 17 with a white luminance level (see Fig. 2-8A). Its position can be changed with the VERT POSITION control on the 146. These



(A) Horizontal bar signal.

(B) Vertical bar signal.

(C) Dot pattern signal.

(D) Both crosshatch and dots as seen on a TV monitor.

Fig. 2-8. Convergence pattern outputs.

pulses correspond to the horizontal bars as seen on a monitor (see Fig. 2-8D.

12. Set the test oscilloscope Time/Cm to 10 μs with no magnification and internal triggering. Set the 146 CROSSHATCH switch to VERT. The display should consist of a composite sync and blanking signal with 16 or 17 positive-going pulses along the line (see Fig. 2-8B). These pulses correspond to the vertical bars on a monitor (see Fig. 2-8D).

13. Set the 146 CONVERGENCE DISPLAY switch to DOTS. The display should be similar to that seen in the previous step, but should have dim positive-going pulses (see Fig. 2-8C). These correspond to the dots on a monitor (see Fig. 2-8D).

14. Set the 146 CONVERGENCE DISPLAY switch to BOTH. The display should consist of both vertical bars and dots. The dot pulses should be between each pair of the vertical bar pulses.

15. Change the cable from the 146 CONVERGENCE PATTERN connector to the COMP BLANKING connector. Set the Type 1A1 Volts/Cm to 1 V and the test oscilloscope Time/Cm to 50 μs. The display should be a series of negative-going pulses with an amplitude of 4 volts peak to peak. Pulse interval is 63.5 μs and pulse duration is approximately 12 μs.

16. Set the test oscilloscope Time/Cm to 5 ms with external triggering. The display should now be the composite blanking signal.

17. Change the cable from the COMP BLANKING connector to the COMP SYNC connector. The display should now be the composite sync signal.

18. Set the test oscilloscope Time/Cm to 50 μs with internal triggering. The display should be a series of negative going-pulses with an amplitude of 4 volts peak to peak. Pulse interval is 63.5 μs and pulse duration is approximately 4.7 μs.

19. Change the cable from the COMP SYNC connector to the SUBCARRIER connector. Set the test oscilloscope Time/Cm to .2 μs. The display should consist of a sine wave, at the subcarrier frequency of 3.579545 MHz, with an amplitude of 2 volts peak to peak.

20. Change the cable from the SUBCARRIER connector to the rear-panel BURST FLAG connector. Set the test oscilloscope Time/Cm to 10 μs. The display should consist of 4 volt negative going pulses.

21. Change the cable from the rear-panel BURST FLAG connector to the HORIZ DRIVE connector. The display should consist of 4 volt negative-going pulses. They are coincident with the horizontal blanking interval.

22. Remove the cable from the rear-panel VERT DRIVE connector. Change the cable from the HORIZ DRIVE connector to the VERT DRIVE connector. Set the test oscilloscope Time/Cm to 10 ms. The display should consist of negative-going pulses with an amplitude of 4 volts peak to peak. They are coincident with the vertical blanking interval.

23. Disconnect the cable from the VERT DRIVE connector and connect it to the COMP VIDEO connector. Reconnect the cable from the test oscilloscope Trigger Input connector to the HORIZ DRIVE connector. Set the test oscilloscope Time/Cm to 10 μs with external triggering. Set the 146 VIDEO switch to OFF and the STEPS switch to OFF. The display should consist of sync and burst only.

24. Set the 146 REF switch to COLOR GEN LOCK. Note that both the amber and red lights are off, which indicates GEN LOCK.

25. Disable Burst of the external composite video signal. (Set the Type 140 Burst switch down.) Note: the 146 red light (loss of subcarrier) comes on and the test oscilloscope display consists of sync and luminance only. Return the "Burst" component of the external signal.

26. Disable the sync of the external composite video signal. (Set the Type 140 Sync switch down.) Note the 146 amber (loss of sync) and the red (loss of subcarrier) indicators light up. Note the display consists of sync only. (With these conditions, the 146 internal generator is providing the sync.) Return the sync to the external composite video signal.

27. Set the 146 REF switch to EXT STD. Note the red light is off, which indicates that the external standard is providing the subcarrier.

28. Disable the external signal standard. (Set the Type 140 Ref switch to Ext.) Note the red indicator light comes on and the display consists of sync and luminance only, which indicates that external standard has been lost. Return the external standard.

29. Set the 146 REF switch to COLOR GEN LOCK. Set the test oscilloscope for X10 magnification and adjust the Horizontal Position control to display the burst portion of the signal. Press the 146 (COLOR LOCK UNLOCK) switch. Note the subcarrier (burst) now free runs. Release the switch.

30. From the external signal source, connect composite video via a 75 ohm coaxial cable and a 75 ohm termination to the Type 1A1 Channel 2 Input connector. Set the external signal for sync and burst only. Set the Type 1A1 Mode switch to Alt and the Channel 2 Volts/Cm switch to the same setting as the Channel 1. Using the Type 1A5 Position and Variable (Volts/Cm) for 1 channel, overlay the two displays.

31. Using a small screwdriver, adjust the 146 LINE SYNC GEN LOCK DELAY control (a front-panel adjustment). Note the 146 signal can be made to lead or lag the external signal. Adjust the control for coincidence on the leading edge of sync.

Procedure 3

A Type R520 NTSC Vectorscope is used as a display device for the following. The Vectorscope provides a means of displaying phase characteristics as well as amplitude information, permitting graphic analysis of hue and saturation in the composite video signal. R, G, B, Y, I, and Q components can also be displayed on the line sweep graticule of the Type R520 NTSC. See the Type R520 instruction manual operating instructions for measurement details.

Differential phase and gain measurements can be made using the Modulated Staircase test signal. The procedure is described in the Type R520 NTSC instruction manual.

1. Connect the COMP VIDEO output on the 146 to the Ch A input on the Type R520 NTSC through a 75 Ω

coaxial cable. Connect a 75 Ω terminating resistor to the unused connector.

2. Set the 146 controls as directed in Step 3 of Procedure 1 except, the COLOR BARS FIELD DISPLAY. Set this selector to FULL FIELD COLOR BARS.

3. Set the Type R520 NTSC controls as follows:

TYPE R520 NTSC

Signal Selector	Full Field, AΦ, Ch A
CH A 100%-75%-Max Gain	75%
Ch A Gain	Cal
A Phase	As is
Ch B 100%-75%-Max Gain	75%
Ch B Gain	Cal
B Phase	As is
Ref	Burst
Function Selector	Vector
Luminance Gain	Cal
Calibrated Phase	0°
Intensity	As desired
Focus	Well defined display
Scale Illum	As desired
Field	1
Sync	Int
Vert Position	Midrange
Horiz Position	Midrange

4. The display should be a vector presentation of the chrominance portion of the color bar test signal.

5. Adjust the A Phase control on the Type R520 NTSC to align the burst vector to the 180° position.

6. Switch the COLOR BAR R—Y selector (on the 146) to the down position. The display should consist of the burst vector and 6 dots on the B—Y (or 0°-180° axis). See Fig. 2-9. This display contains only the B—Y component of the color bar and is useful for setting up B—Y amplitudes of the color segments. Inscribed scale markings on the graticule facilitate the check.

Return the R—Y lever switch to the up position.

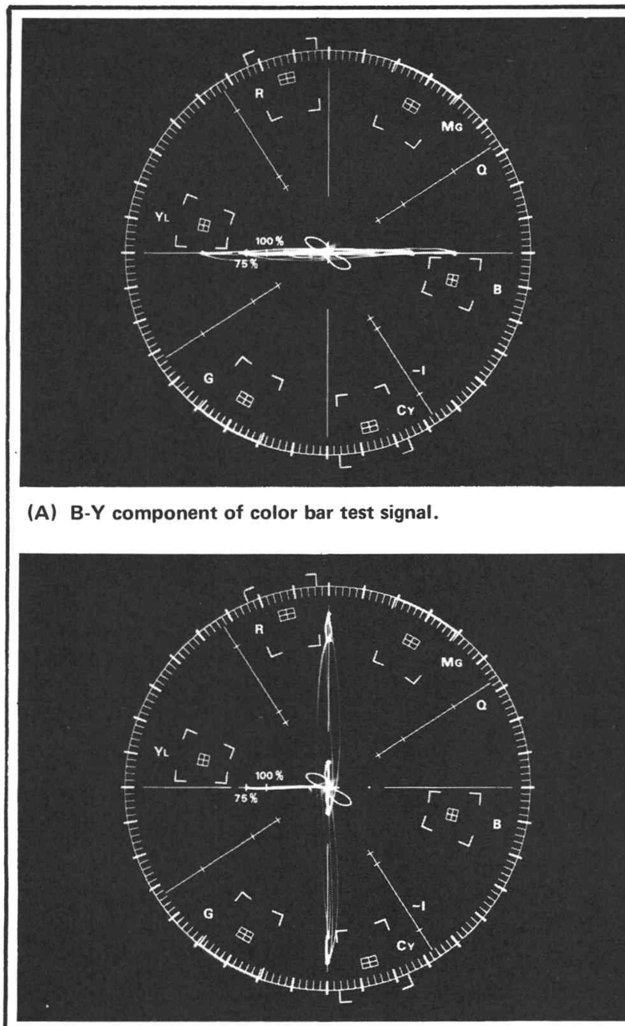
7. Switch the COLOR BARS B—Y selector (on the 146) to the down position.

The display should consist of a vertical row of 6 dots plus the burst vector at 180°. See Fig. 2-9B. This display contains the R—Y component of the color bar, and is useful for setting up the R—Y amplitude of the color segments. Inscribed scale markings on the graticule facilitate the check.

Return the B—Y lever switch to the up position.

8. In the previous two steps, if the R—Y and B—Y amplitude (dots) fell on or very near their corresponding scale markings, then all color vectors should fall within their respective inner boxes on the graticule (indicating that they are within ±2.5° phase and ±2.5 IRE amplitude error limits) when both R—Y and B—Y components are present in the color bar signal (see Fig. 2-10).

9. Switch the COLOR BARS FIELD DISPLAY selector on the 146 to EIA COLOR BARS. There should be two



(A) B-Y component of color bar test signal.

(B) R-Y component of color bar test signal.

Fig. 2-9. Vector display of color bar test signal containing only the B—Y or R—Y components.

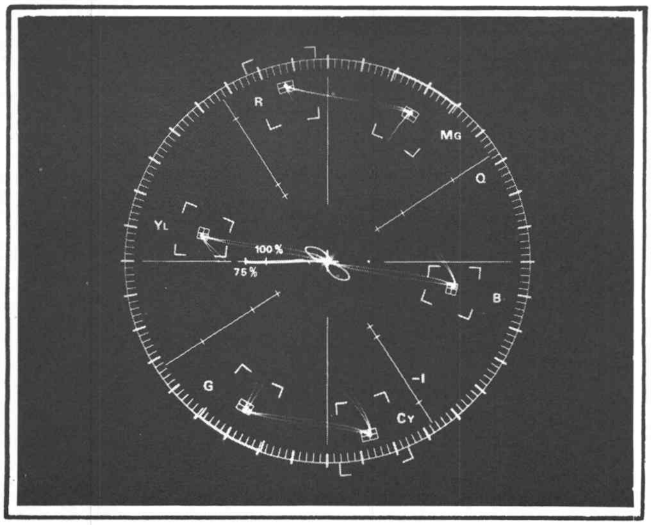


Fig. 2-10. Vector presentation of the color bar test signal. Position of the dots within the smaller boxes indicates that the displayed color vectors are within ±2.5°, and ±2.5 IRE in amplitude.

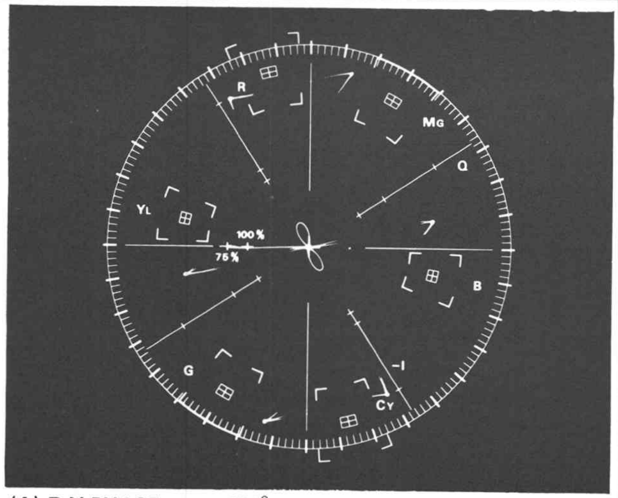
additional vectors on the display; one on the Q axis, and one on the −I axis. Return the FIELD DISPLAY switch to FULL FIELD COLOR BARS.

10. Switch the 146 SYNCHRONIZATION R−Y PHASE selector to the 270° position. The vectors should now be inverted, as shown in Fig. 2-11A.

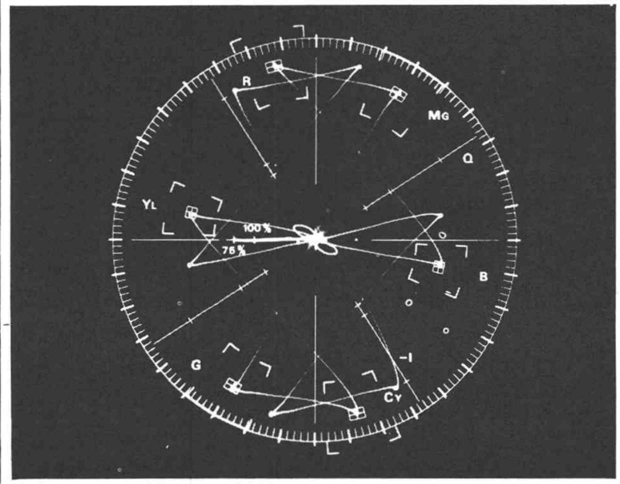
11. Set the 146 SYNCHRONIZATION R−Y PHASE lever switch to the ALT position. This alternates the phase of the R−Y subcarrier between 90° and 270° at the H-rate (see Fig. 2-11B). Return the R−Y PHASE lever switch to the 90° position.

12. Set the 146 VIDEO switch to the down position. There should be a burst vector at 180° and a subcarrier vector at 180°.

13. Rotate the 146 APL/IRE LEVEL switch to 0, and set the MOD STAIRCASE 90° SUBCARRIER switch to MOD. The display should consist of a burst vector at 180°, a subcarrier vector at 180°, and three dots along the 90° axis corresponding to the modulated 90° subcarrier. See Fig. 2-12.



(A) R-Y PHASE set to 270°.



(B) R-Y PHASE set to ALT.

Fig. 2-11. Vector display of color bar signal with R−Y PHASE set to 270° and ALT.

OPERATING OPTIONS

General Information

In specific user applications the 146, as factory connected, may not provide certain components of a test signal(s) when desired. For example: if operating in the COLOR GEN LOCK mode, loss of the external 3.58 MHz component will automatically prevent any chroma information from being obtained from the 146. This loss of chroma may not be desirable. By changing a circuit board pin connection, the chroma information may be obtained. The following changes can be performed if desired.

A. Staircase Modulation Phasing

The 146 is factory connected to provide a modulated staircase test signal with the modulation phased at 180°. (Burst is also phased at 180°.) To produce the staircase test signal with the modulation phased at 0°, move the center conductor of the orange-on-white coaxial cable, located on the Modulator circuit board, from pin P to pin R (see Fig. 2-13 and diagram 1).

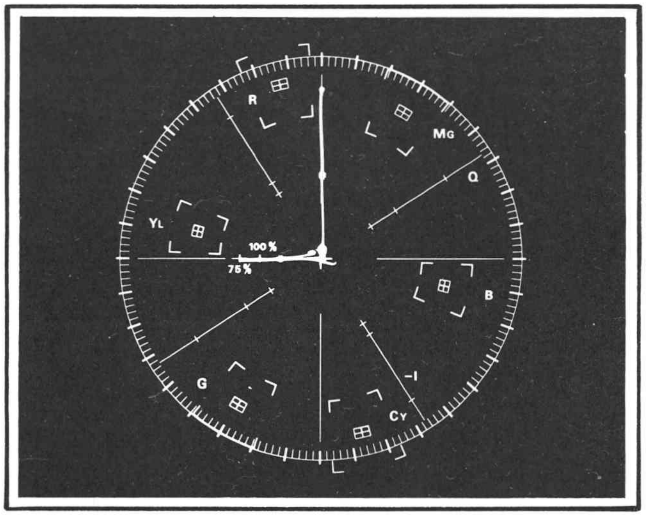


Fig. 2-12. Vector presentation of 180° and modulated 90° subcarriers.

B. Line Sync Lock Time

When operated in the COLOR GEN LOCK mode, the 146 will line lock to the external signal in approximately 50 ms. To obtain a slower lock with the external signal, change the black wire between pins X and Y on the Line Timing circuit board to pins Y and Z (see Fig. 2-14 and diagram 6b). In this mode, the 146 line lock rate is limited to about 1 line/sec.

C. Auto—Non Auto Chroma

When operated in COLOR GEN LOCK or EXT STD modes, the 146 is factory connected to disable the

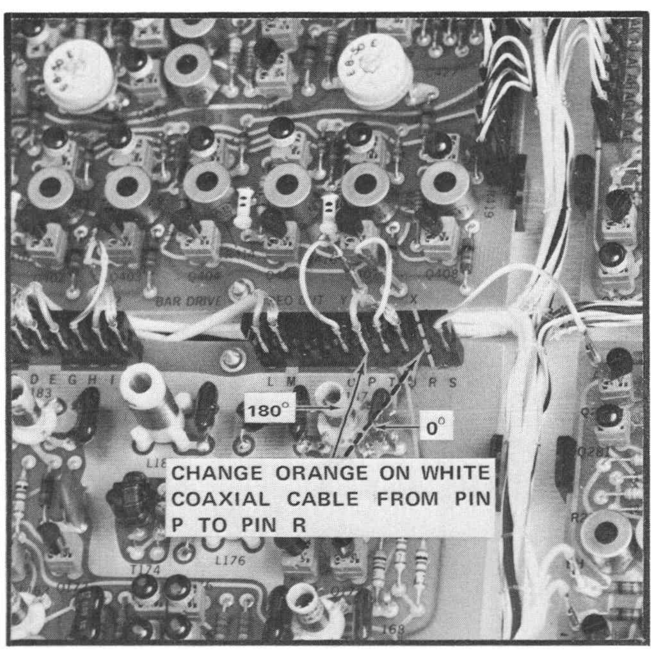


Fig. 2-13. Modulator circuit board showing location of coaxial cable used to change staircase modulation phasing.

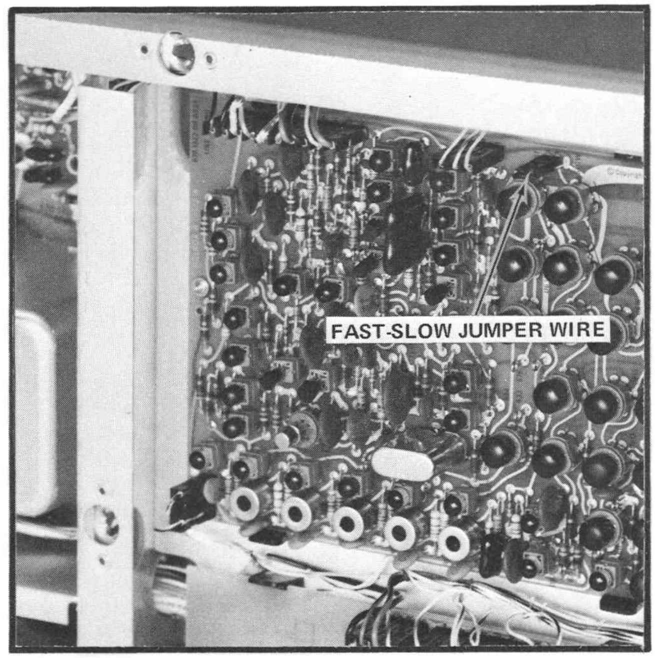


Fig. 2-14. Line Timing board showing location of FAST-SLOW line sync lock jumper.

chrominance components of the COMP VIDEO outputs if the external 3.58 MHz component is lost. (Also, if external sync is lost in COLOR GEN LOCK mode only.) To provide chrominance information even with the external loss of subcarrier, move the black-brown on white wire, located on the Gen Lock circuit board, from pin R to pin S (see Fig. 2-15 on diagram 16).

NOTE

When the 146 is operated in the COLOR GEN LOCK mode and the externally applied Gen Lock signal is monochrome (no burst), the SUBCARRIER outputs revert to the internal subcarrier (within FFC frequency specifications), but the SYNC outputs are locked to the incoming signal. Thus, the SYNC and SUBCARRIER outputs are not 'color locked'. Color signals generated in this mode cannot be used with a Video Tape Recorder (VTR).

D. Auto-Non Auto Video

When operated in the COLOR GEN LOCK mode, the 146 is factory connected to eliminate the luminance portion of the output if the external sync signal is lost. To obtain luminance at all times, move the red-violet-on-white wire, located on the Gen Lock circuit board pin AA, to pin Z (see Fig. 2-15 and diagram 15).

E. CW Subcarrier Lock

If desired, the 146 can be Gen Locked to a composite sync signal with superimposed subcarrier. This is accomplished by changing the black jumper wire

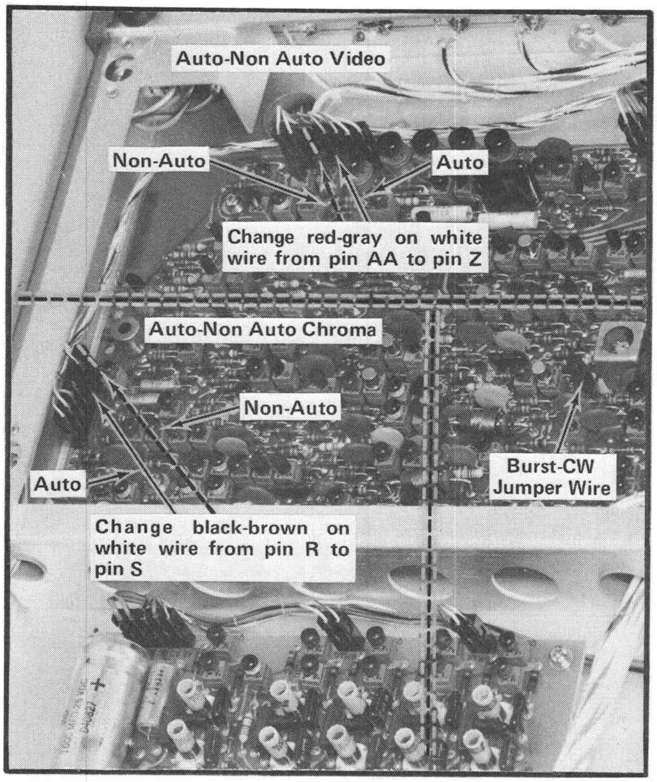


Fig. 2-15. Gen Lock circuit board showing location of pins to convert Auto—Non-Auto Chroma and Auto—Non-Auto Video; jumper wire for selecting Burst or CW operation.

on the Gen Lock circuit board from the BURST position to the CW position (see Fig. 2-15 and diagram 12).

GLOSSARY OF TERMS

ACTIVE VIDEO LINES: All video lines not occurring in the vertical blanking interval.

APL: Average picture level. The average luminance level of the unblanked portion of a television line measured in IRE units.

BACK PORCH: That portion of the composite video signal which lies between the trailing edge of the horizontal sync pulse and the trailing edge of the horizontal blanking pulse.

BLACK BURST: A signal consisting of composite sync and burst.

BLANKING LEVEL: The level of the front and back porches of the composite video signal.

BREEZEWAY: In NTSC color, the portion of the back porch between the trailing edge of the sync pulse and the start of the color burst.

BURST FLAG: Pulses used to key out a portion of the 3.579545 MHz sine wave subcarrier for use as a reference for the color signal.

B—Y: A color signal corresponding to the 0° axis of a vector diagram. It is formed from a combination of red, green, and blue chrominance signals (B—Y=—0.30R—0.59G+0.89B).

CHROMINANCE: That property of light which produces a sensation of color in the human eye apart from any variation in luminance that may be present.

COLOR BAR: A test signal, typically containing six basic colors: yellow, cyan, green, magenta, red, and blue, which is used to check the chrominance functions of color TV systems.

COLOR BURST: In NTSC color systems, this normally refers to a burst of approximately 8 to 10 cycles of 3.579545 MHz subcarrier frequency on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

COLOR SUBCARRIER: In color systems, this is the carrier signal whose modulation sidebands are added to the monochrome signals to convey color information; in NTSC, it is a 3.579545 MHz sine wave.

COMPOSITE BLANKING: This signal is composed of pulses at line and field frequencies used to make the return traces of a picture tube invisible.

COMPOSITE SYNC: The line and field rate synchronizing pulses (including the field equalizing pulses) when combined together form the composite sync signal.

COMPOSITE VIDEO: For color, this consists of blanking, field and line synchronizing signals, color synchronizing signals, chrominance and luminance picture information. These are all combined to form the complete color video signal.

CONVERGENCE: In color television, the meeting or crossing of the three electron beams at the shadow mask.

CROSSHATCH: A grid of vertical and horizontal white bars over a black background.

DIFFERENTIAL GAIN: The amplitude change, usually of the 3.579545 MHz color subcarrier, introduced by the overall circuit, measured in dB or per cent, as the picture signal on which it rides in varied from blanking to white level.

DIFFERENTIAL PHASE: The phase change of the 3.579545 MHz color subcarrier introduced by the overall circuit, measured in degrees, as the picture signal on which it rides is varied from blanking to white level.

EIA: An abbreviation for Electronic Industries Association.

EQUALIZING PULSES: Pulses of one half the width of the horizontal sync pulses which are transmitted at twice the rate of the horizontal sync pulses during the portions of the vertical blanking interval immediately preceding and following the vertical sync pulses. The purpose of these pulses is to cause the vertical deflection to start at the same time in each interval, and also serves to keep the horizontal sweep circuits in step during the portions of the vertical blanking interval immediately preceding and following the vertical sync pulse.

FIELD: One half of a complete picture (or frame) interval, containing all of the odd, or all of the even, lines of the picture.

FIELD BLANKING: Refers to the blanking signals which occur at the end of each field. Also called vertical blanking.

FIELD FREQUENCY: The rate at which one complete field is scanned, normally 59.94 times a second.

FRAME: One complete picture consisting of two fields of interlaced scanning lines.

FRONT PORCH: That portion of the composite picture signal which lies between the leading edge of the horizontal blanking pulse and the leading edge of the corresponding sync pulse.

GEN LOCK: Synchronization of signals in both frequency and phase.

H RATE: The time for scanning one complete line, including trace and retrace. NTSC equals 1/15734 second (color) or 63.56 μs.

HORIZONTAL DRIVE: A pulse at H-rate used in TV cameras. Its leading edge is coincident with the leading edge of the horizontal sync pulse and the trailing edge is coincident with the leading edge of the burst flag pulse.

HUE: The attribute of color perception that determines whether the color is red, yellow, green, blue, or the like. White, black, and gray are not considered hues.

IRE: An abbreviation for Institute of Radio Engineers.

IRE SCALE: An oscilloscope scale that applies to composite video levels. There are 140 IRE units in 1 volt.

—I, W, Q, B: An NTSC test signal used to check television broadcase equipment. It consists of a —I signal followed by a white bar then a Q signal and a black level on each line.

LINE BLANKING: The blanking signal at the end of each scanning line. Used to make the horizontal retrace invisible. Also called horizontal blanking.

LINE FREQUENCY: The number of horizontal scans per second, normally 15,734.26 times per second.

LUMINANCE: The amount of light intensity, which is perceived by the eye as brightness (referred to as "Y").

NTSC: National Television Systems Committee. An industry-wide engineering group which, during 1950-1953, developed the color television specifications now established in the United States.

REFERENCE WHITE LEVEL: The level corresponding to the specified maximum excursion of the luminance signal in the white direction.

R—Y: A color signal corresponding to the 90° position of a vector diagram. It is formed from a combination of red, green, and blue chrominance signals (R—Y=0.70R—0.59G—0.11B). Any color on the vector diagram can be made from a combination of R-Y and B-Y signals.

SATURATION: This indicates how little a color is diluted by white light, distinguishing between vivid and weak shades of the same hue. The more a color differs from white, the greater is its saturation. Saturation is also indi-

cated by the terms purity and chroma. High purity and chroma correspond to high saturation and vivid color.

SETUP: The separation in level between blanking and reference black levels.

STAIRCASE: A video test signal containing several steps at increasing luminance levels. The staircase signal is usually amplitude modulated by the subcarrier frequency and is useful for checking amplitude and phase linearities in video systems.

SYNC: An abbreviation for the words "synchronization", "synchronizing", etc. Applies to the synchronization signals, or timing pulses, which lock the electron beam of the picture monitors in step, both horizontally and vertically, with the electron beam of the pickup tube. The color sync signal (NTSC) is known as the color burst.

VERTICAL BLANKING INTERVAL: The blanking portion at the beginning of each field. It contains the equalizing pulse, the vertical sync pulses, and VITS (if desired).

VERTICAL DRIVE: A pulse at field rate used in TV cameras. Its leading edge is coincident with the leading edge of the vertical blanking pulse and its duration is 10.5 lines.

VITS: Vertical interval test signal. A signal which may be included during the vertical blanking interval to permit on-the-air testing of video circuitry functions and adjustments.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section begins with a block diagram description, describing signal flow and circuit function, fòllowed with circuit operation of each block. Complete block diagrams are provided in Section 9 on pullout pages. (Exception: no blocks are shown for the power supply.)

Because of the numerous interconnections between stages, the block diagram is drawn in two sections. Block Diagram I includes those stages required to generate subcarrier (or to allow the use of external subcarrier) and those systems or stages required for external sync processing. Block diagram II covers the stages that produce output signals except the subcarrier.

GENERATING SUBCARRIER

Refer to Block Diagram I and assume the REF switch is as shown (INT position).

The master oscillator (labeled SC OSC) generates the 3.579545 MHz subcarrier. The oscillator is controlled by a resistive divider in the Subcarrier Reference circuit. The oscillator is free-running and can be adjusted so its frequency is within 5 Hz of 3.579545 MHz. (See External Sync Processing block diagram description for exception.)

An Oscillator Oven and Oven Temp Normal circuit insures a constant temperature for the components of the master oscillator, and provides a visual check of the oven temperature (OVEN TEMP NORMAL lamp).

The subcarrier signal from the oscillator is then applied to an Oscillator Buffer stage, which isolates the oscillator and maintains a constant subcarrier output amplitude. The subcarrier is then applied to the Int-Ext Subcarrier Switch.

The electronic Int-Ext Subcarrier Switch selects either the internal subcarrier source or an external subcarrier signal (applied via the SUBCARRIER Input connector and an Input Amplifier) to be used within the 146. Both the Subcarrier Detector and Lamp & Switch Logic stages will sense the presence of an external subcarrier, and switch the Int-Ext Subcarrier Switch so the external subcarrier is substituted for the internal subcarrier (REF switch in EXT STD position only). The Subcarrier Detector also drives the Lamp & Switching Logic to turn on the loss of burst indicator (AUTO INT SUBCARRIER Lamp), should loss of external subcarrier occur.

The subcarrier signal is then applied to the Switch Buffer, Limiting Buffer and the Gonimeter Drive & Subcarrier Output Amplifiers. The latter, a distribution amplifier, drives all circuits within the 146 that require subcarrier and the front and rear-panel SUBCARRIER connectors.

With the REF switch in COLOR GEN LOCK position, subcarrier is generated in the same manner as it was in INT mode with two exceptions: (1) the control voltage for the SC OSC, from the Subcarrier Reference Switch, is now dependent on the phase and amplitude of an externally applied composite video signal (applied to the GEN LOCK Input connector) and (2) the Lamp & Switch Logic circuit is now controlled by the Quad Lock Detector stage instead of the Subcarrier Detector Stage.

GENERATING VERT DRIVE, HORIZ DRIVE, COMP SYNC, CONVERGENCE PATTERN, BURST FLAG, AND COMP BLANKING OUTPUT SIGNALS

Refer to Block Diagram II and assume the REF switch (Block Diagram I) is as shown (INT position).

The timing for these output signals must be referenced to a common source, which in turn must be referenced to the internal or external (depending on mode) subcarrier. This timing source is the Line Frequency Control Oscillator. Its frequency is counted down by the Line Counter logic circuit and applied as timing reference to the various output signal generators. The Line Frequency Control oscillator is phase locked to the subcarrier by sampling the subcarrier, every 455 cycles, and comparing this sample against the Line Counter frequency. Any differential is then fed back as a DC correction voltage to the Line Frequency Oscillator. The Line Frequency Control Oscillator, Line Counter, Line Detail Timing, Sample Gate, Phase Lock Sampler, Int-Ext Sync Switch, Phase Lock Reference Amplifier, and the DC Control Loop Amplifier perform this function.

The Line Frequency Control Oscillator frequency is 1.006993 MHz, which is the 64th harmonic of the 15734 Hz line rate. This is also directly related to the 3.579545 MHz subcarrier frequency. The 1.006993 MHz signal then drives the Line Counter to produce the various timing signals used in the 146. On the 32nd, 64th, and 128th divisions, signals are generated within the Line Counter which drive the Line Detail Timing and Sample Gate Stages. An output from the Sample Gate unlocks the Phase Lock Sampler, and the subcarrier is sampled via the Int-Ext Sync Switch and Phase Lock Reference Amplifier. This occurs every 455th cycle of the subcarrier. Any time-shift of the line Counter sampled against the subcarrier produces a DC correction voltage that is applied through the DC Control Loop Amplifier to the Line Frequency Control Oscillator.

If the REF switch is changed to COLOR GEN LOCK position and an external composite video signal is applied to the GEN LOCK Input connector, processed composite sync, from the Sync Strip system (see Block Diagram I and description for Sync Strip), drives the 15 kHz Phased Lock Multivibrator. The multivibrator output is a square wave, corresponding to the composite sync, which is integrated by the Limiting Ramp Generator and applied to the Int-Ext Sync Switch. The electronic switch substitutes this integrated composite sync pulse for the subcarrier and applies the pulse to the Phase Lock Reference Amplifier. This signal is sampled and is the reference for the Line Frequency Control Oscillator.

The HORIZ DRIVE output is obtained as follows: a 15734 kHz signal from the Line Counter sets the Horizontal Drive Gate. A second signal from the Line Counter drives the Line Detail Timing stage, and about 6.35 μs later, a pulse from the Line Detail Timing stage resets the Horizontal Drive Gate. This generates a Horizontal drive signal, which is applied to the Horizontal Drive Output Amplifier for amplification and distribution to the 146 front and rear-panel HORIZ DRIVE connectors.

The VERT DRIVE Signal output is obtained by driving the Field Counter (a 525 state counter) with a 31 kHz signal from the Line Counter. A pulse from the divide-by-two counter, within the Field Counter, sets a gate within the Field Logic stage. Later, a pulse from the Field Counter resets the Field Logic gate to produce the Vertical Drive signal. This signal is amplified by the Vertical Drive Output Amplifier and applied to the VERT DRIVE connector.

To obtain COMP SYNC, COMP BLANKING, and BURST FLAG, timing signals from the Line Counter, Line Detail Timing, and Field Logic circuits are combined in the Composite Sync, Composite Blanking and Burst Logic stages, to produce drive signals for their respective output amplifiers. These signals are amplified and applied to the 146 front and rear-panel output connectors.

The CONVERGENCE PATTERN output is produced by driving the Crosshatch & Dot Generator with line blanking, field blanking and a 15734 kHz signal from the Line Counter. The output of this stage is applied to the Convergence Output Amplifier, and combined with composite sync and blanking. The resultant signal is amplified and applied to the front and rear-panel CONVERGENCE PATTERN connectors.

GENERATING MODULATED STAIRCASE COMPOSITE VIDEO OUTPUT SIGNAL

Chrominance

To produce the chrominance portion of the modulated staircase, subcarrier must be present to enable the Chrominance Output Amplifier. (See block diagram description on generating composite video following this section.)

Field and line timing signals are applied to the Video Logic stage to time and produce (1) staircase field drive and (2) APL field drive signals. The staircase field drive signal is applied, via the 180° SUBCARRIER switch, to the Staircase Chrominance Amplitude stage, where it is combined with another gate from the Staircase Timing Logic stage. The combination of these two signals produces an output signal which is then applied to the B—Y Filter. A burst signal from the Burst Amplitude stage is also applied to the B—Y Filter. The B—Y Filter limits the frequency response of each input and drives the B—Y Modulator. There, it is modulated by the subcarrier to produce a modulated B—Y signal output. This output is applied through the Bandpass Filter which has a center frequency response of 3.58 MHz. Only the chrominance signal, therefore, gets through the filter and is applied to the Chrominance Output Amplifier for amplification. The amplified Chrominance signal is then applied to the COMP VIDEO output connectors.

If the 180° SUBCARRIER and STEPS switches are in the off position and the 90° SUBCARRIER switch is switched to the UNMOD or MOD positions, the staircase field drive signal is applied through the 180° SUBCARRIER switch to the APL Chrominance stage. APL field drive signals (from the Video Logic stage) plus signals from the Staircase Timing Logic stage, and line blanking are also applied to the APL Chrominance stage. These signals combine within the stage to produce the APL Chrominance signal. This signal is then applied to the R—Y Filter and R—Y Modulator, where it is modulated by the subcarrier from the 0°-180° Phase Shifter. Burst from the Burst Amplitude stage is applied through the B—Y Filter to the B—Y Modulator, where it is also modulated by the subcarrier from the Subcarrier Modulator Driver. The output of the R—Y, B—Y Modulators is a signal with burst displaced 90° from the APL Chrominance. This signal is applied through the Bandpass Filter to the Chrominance Output Amplifier as previously described.

Luminance

Staircase Field Drive from the Video Logic stage is combined with Staircase Timing Logic signals in the Staircase Luminance Amplitude stage to produce the luminance portion of the staircase signal. The output of the Staircase Luminance Amplitude stage is then applied to the Narrow Band Filter. The APL Luminance, which is controlled by the setting of the APL/IRE LEVEL switch and APL Field Drive from the Video Logic stages, is also coupled to the Narrow Band Filter. Harmonic frequencies that may adversely affect the chrominance in the output are attenuated by the filter. The filter output is then applied to the Luminance Output Amplifier. Composite sync, via the Wide Band Filter (see block diagram description for generating composite video), is also applied to the Luminance Output where it is combined and amplified and applied to the COMP VIDEO output connector.

Note that separate output amplifiers are used; one for the chrominance (Chrominance Output Amplifier) and one for luminance (Luminance Output Amplifier). Separate amplifiers minimize Differential Phase and Differential Gain.

GENERATING FULL FIELD COLOR BAR OR EIA COLOR BAR COMPOSITE VIDEO OUTPUT SIGNAL

This description is presented in two parts (1) Color Bar and (2) Split Field. Each of these parts is again separated into two subparts (1) Chrominance and (2) Luminance.

Color Bar Chrominance

The Chrominance Enable circuit enables the Chrominance Output Amplifier only when subcarrier is present to allow the chrominance signal to get through to the COMP VIDEO output connectors.

Assume that the Bar Oscillator is on and the last color bar (blue) is being generated. At the end of the blue color bar, the COMP VIDEO output signal drops to black or blanking. At this time, a stop signal generated within the Color Bar Chrominance Counter & Logic stage is applied to the Bar Oscillator Start & Stop Control Stage, to disable the Bar Oscillator; color bars cease.

At a predetermined time during the line blanking interval, a preset pulse, developed by the Bar Oscillator Start and Bar Preset circuit, presets the ÷ 4 Counter, the Color Bar Chrominance Counter & Logic; and the Color Bar Luminance Counter & Logic stages. This insures that the chrominance and luminance counters are synchronous. Prior to the position of the white bar, equivalent to a period for one cycle of bar oscillation, a second pulse is generated within the Bar Oscillator & Bar Preset circuit which, when applied to the Bar Oscillator Start-Stop Control Stage, enables or starts the Bar Oscilator. After one cycle of oscillation, the Bar Oscillator output toggles the ÷ 4 Counter, and color bars are again produced at the COMP VIDEO outputs.

Three gate signals (corresponding to the red, green, and blue color) are applied to the Color Bar Chrominance Amplitude stage from the Color Bar Chrominance Counter & Logic circuits. Besides these gate signals, color bar field drive signals from the Video Logic stage (via the R—Y and B—Y switches), and amplitude setting voltage levels from the Color Bar & Setup Supplies, are also applied to the Color Bar Chrominance Amplitude stage. This combination of signals (1) sets the amplitude of the red, green, and blue and (2) forms the ±R—Y and the ±B—Y color bar drive signals. These signals are then applied through the B—Y and R—Y Filters to the modulators. Burst, via the Burst Amplitude stage, also is applied to the filters.

Subcarrier is applied to the Subcarrier Phase (goniometer; see Block Diagram (I) stage. This stage allows the operator to vary the phase of the subcarrier that is applied to the B—Y Modulator and (R—Y) (B—Y) Quad Phase stages. The quad phase circuit shifts the phase of the subcarrier 90° and applies it to the 180° Phase Switcher. The output of this stage then drives the R—Y Modulator. The Modulators operate in a double balanced configuration which produces an output which contains only the required sidebands of chrominance information. This chrominance information is applied through the Bandpass Filter to the Chrominance Amplifier and COMP VIDEO outputs.

Color Bar Luminance

The output from the ÷ 4 Counter is also applied to the Luminance Delay stage which delays the luminance portion of the output signal so that chrominance and luminance information are properly combined at the COMP VIDEO output connectors.

The output of the Color Bar Luminance Counter & Logic stage consists of gate signals that correspond to the luminance red, green, and blue. These gate signals are applied to the Color Bar Luminance Amplitude stage. The field and line drive signals plus amplitude-setting voltages, from the Color Bar & Setup Voltage Supplies stage are also applied to this amplitude setting stage. The Color bar luminance output is then applied to the Wide Band Filter.

The Wide Band Filter is also driven by composite sync, from the Composite Sync Amplitude stage and both signals are combined to provide color bar luminance amplitude steps. This luminance signal is then applied to the Lumi-

nance Output Amplifier for amplification and use at the COMP VIDEO output connectors.

Split Field Chrominance

In the EIA COLOR BAR mode of operation, the chrominance circuit operation is similar to the FULL FIELD COLOR BAR mode operation, with the addition of the I, Q Chrominance Amplitude, and the Bar Oscillator Frequency Control stages.

With —I, W, Q, B operation, the Bar Oscillator Frequency Control stage is used to control the frequency of the Bar Oscillator, which then controls the I, Q Timing.

The I, Q Chrominance Logic stage is gated by a signal from the Color Bar Luminance Counter & Logic stage and the Color Bar Chrominance & Logic circuitry. The output I and Q drive signals are then applied to the I, Q Chrominance Amplitude stage, which is gated on by the I, Q drive gates from the Video Logic stage. The output I, Q Chrominance signals are then applied to the B—Y and R—Y Filters and the chrominance stages described in the first part of this block diagram.

Split Field Luminance

In the —I, W, Q, B mode of operation, the luminance circuits operate as in the FULL FIELD COLOR BAR mode with the addition of the I, Q White Drive and the I, Q White Reference Amplitude stages.

The I, Q White Gate Drive stage is gated by gates from the Color Bar Luminance and Color Bar Chrominance Logic stages, to produce the I, Q White Drive gate. This gate is then applied to the I, Q White Reference Amplitude stage which produces the I, Q White Reference pulse. This is then applied to the Narrow Band Filter and processed the same as previously described in the luminance portion for generating color bars.

EXTERNAL SYNC PROCESSING

Refer to Block Diagram I and assume (1) the REF switch is set to COLOR GEN LOCK position and (2) composite video is applied to the 146 GEN LOCK input connector. The external composite video is applied to the Sync Strip and Burst Processing Systems.

Sync Strip

The AGC Amplifier, Summing Amplifier, Sync Tip Comparator, 50% Level Comparator, Memory Level, High Pass Filter, Low Pass Filter, Blanking Level Comparator, and the Low Pass Filter comprise the Sync Strip system. The composite sync portion of the externally applied composite video signal is striped and processed so that the composite sync signal out corresponds to the externally applied signal, but is free of sync tilt, hum, etc. This composite sync signal is then used to drive the Burst and Field Processing Circuits.

Burst Processing

Burst processing consists of the Chroma AGC Amplifier, Quad Demodulators, Chroma AGC Comparator, and Subcarrier Logic stages. These stages produce signals that correspond to the phase and amplitude of the chrominance portion of the externally applied composite video signal. These signals control the phase of the internal Subcarrier master oscillator.

Chroma AGC Amplifier. This stage consists of the Chrominance Pickoff, Chrominance Buffer, AGC Control, Switch Buffer Amplifier, and Output Amplifier circuits. The chrominance and luminance portions of the externally applied composite video signal are separated by the Chrominance Pickoff circuit, and amplified by the Output Amplifier. Chrominance amplitude is controlled by the AGC Control circuit. The Output Amplifier drives the Quad Demodulator stage.

Quad Demodulators. This stage consists of the Quad Phase & Limiting Drivers, Quad Demods, Low Pass Filters, AC Pulse Amplifiers, Quad Phase Burst Rectifiers, Burst Tip Detectors, Buffer Amplifiers, and DC Restore Clamp circuits.

The Quad Phase & Limiting Drivers, driven by internal subcarrier, and the Back Porch Gate Generator, drive the Quad Demods during back porch time, to demodulate the chrominance signal from the Chroma AGC Amplifier. The demodulated signals are then amplified by the AC Pulse Amplifiers which drive the Buffer Amplifiers and Quad Phase Burst Rectifier circuits. The Burst Rectifier provides a negative pulse that depends on the largest quad signal (positive or negative) from the Quad Demodulators. This pulse is rectified by the Burst Tip Detector and fed back as a clamp to DC-restore the input to the 500 Hz Filters. These signals drive the AGC Comparator and Subcarrier Logic stages.

AGC Comparator & Subcarrier Logic. This stage (1) controls the overall chrominance gain of the Chroma AGC Amplifier; (2) detects presence of external burst; and (3) provides the DC control voltage which synchronizes the 146 internal subcarrier oscillator with the externally applied chrominance signal.

The signals developed in the Quad Demodulator stage drive the 500 Hz Filters, Rectifiers, Peak Detectors, Quad Lock Detector, and the Error Amplifier. The filters, rectifiers, and peak detectors produce a DC level to drive the AGC Comparator and Burst Present Detector. This DC level depends on the phase and amplitude of the external chrominance signal. This DC level causes (1) the Burst Present Detector to switch the Subcarrier Ref Switch from a free run mode to a control mode, controlled by the Error Amplifier, and (2) controls the AGC Comparator (if required) to set the overall chrominance gain through the AGC Amplifier.

The signals developed in the Quad Detectors also drive the Quad Lock Detector and Error Amplifier. The Quad Lock Detector switches the Band Switch which changes the gain of the Error Amplifier to decrease or increase the rate and amount the internal oscillator frequency is changed.

Field Processing System

This system consists of the Non-Sync Inhibit, Vertical Sync Integrator, Peak Detector, Buffer Amplifier, Serration Counter, Counter Preset and the Sync Present Gate stages. The system produces an output signal necessary to synchronize the 146 internal Field Counter (Block Diagram II) with the externally applied composite video field information.

Composite sync, processed in the Sync Strip System, is integrated by the Vertical Sync Integrator and peak detected to produce pulses (six every field) to drive the Serration Counter and Counter Preset circuits. (The Vertical Sync Integrator is disabled by the Non-Sync Inhibit if no sync is present.) A positive field pulse is obtained each field, which is used to preset the 146 internal Field Counter in step with the externally applied composite sync. If the field pulse is not obtained, the Sync Present Gate disables the Burst Processing System and turns on the loss of sync and burst indicators.

INTEGRATED CIRCUITS

Many of the functions within the 146 are performed by integrated circuits. Complexities of the television composite video signal require numerous counting and logic functions for development of the signals.

Knowledge of the internal workings of the various integrated circuits is not necessary for an understanding of circuitry in the 146, since the circuit description is concerned primarily with signal conditions at the input and output terminals of each unit.

In the circuit description that follows and on the circuit diagrams provided in Section 9, the level indicating symbols are used in a manner known as POSITIVE LOGIC. A small circle between the input or output terminal and the connecting lead indicates that the signal causing the desired reaction at that point will be low. The absence of a small circle indicates that the desired signal at that point will be high. A high indicates a more positive voltage level, while a low represents a less positive (or ground) level signal.

MODULATOR ⟨1⟩

Subcarrier Limiter & Modulator Driver

Q114 through Q118 comprise the Subcarrier Limiter and Modulator Driver circuit. This circuit ensures that the modulator is always driven with the same amplitude of subcarrier signal, whether the subcarrier is supplied from an internal or external source. The circuit also corrects for symmetry in the input waveform, to ensure that the modulator is driven with a balanced waveform.

The input stage, Q114, with diodes CR104 and CR105, amplifies and limits the peak-to-peak subcarrier amplitude to approximately 1.1 volts.

The limited (squared) subcarrier signal at the collector of Q114 is coupled through C105 to a paraphase amplifier (Q115 and Q116) which drives the push-pull output stage (Q117 and Q118). C115-R106 and C116-R116 integrate the signal, changing the squared wave to a trapezoidal waveform. This signal is AC coupled through C117 and C118 to the base of Q117 and Q118, providing a drive signal with a 50% duty factor.

The amplitude of the triangular signal at the bases of Q117 and Q118 drives them into saturation and cutoff, producing a square wave signal across the primary windings of T127 at the subcarrier rate.

0-180° Phase Switcher

The 0-180° Phase Switcher circuit consists of U102, Q111, Q112, Q113, Q122, and Q123. This circuit selects the phase of the R—Y component.

U102, a JK Flip-Flop, is triggered by the trailing edge of the inverted Bar Preset signal via Q113 at the line rate.

Q111 and Q112 serve as push-pull drivers for Q122 and Q123 which drive the primary of T144. For any given line, one side (for example Q122) will be saturated, while the other side (Q123) is reversed biased to a point where the collector-base junction conducts in the reverse direction.

(R—Y) (B—Y) Quad Phase

The subcarrier signal is coupled from T127 through the Quad Phase circuitry consisting of C125, C127 and L126. The subcarrier is shifted 90° allowing modulation in all quadrants.

The subcarrier signal is then applied to the primary center tap of T144. During a line when Q122 (see 0-180° Phase Switcher) is saturated (270°), the subcarrier signal current flows through half of T144 primary and Q122. During a line where Q123 is saturated, the subcarrier current flows through the other half of T144 primary and Q123. With the R—Y Phase switch set at the ALT position, the signal appearing across the output of T144 is shifted 180° in phase each line.

(R—Y) (B—Y) Filters

The ± (B—Y) and ± (R—Y) Filters are identical and consist of an LC Pi network. Each filter limits the bandwidth of its drive signal to approximately 1.5 MHz, which prevents any R—Y or B—Y component from exceeding the 3.58 MHz modulating frequency. These filters are adjusted so the phase shift through each is the same. The electrical characteristics of the filters must be identical, since the composite signal is formed after the filters in a differential amplifier stage. Separate handling of the + and — components is required to achieve carrier balance stability.

R—Y and B—Y Double Balanced Modulators

Except for the phase-shifting of the R—Y axis components with respect to the B—Y axis components, the two modulators are identical. The following describes the operation of the B—Y Modulator.

The modulator stage is a double balanced modulator or mixer. This cancels the two input driving signals (modulated carrier and B—Y modulation) and retains the sidebands of the two input signals.

The modulator consists of a differential comparator, Q157 A and B, driving the balanced mixer Q166, Q176, Q156, and Q146.

The subcarrier signal, via T136 drives the bases of Q166-Q156 and Q176-Q146. Base drive to Q176-Q146 is 180° out of phase with Q166-Q156. The resultant output across the collector load (T174) is therefore zero. The B—Y modulating signals, via the filters, drive Q166-Q176 and Q146-Q156 emitters with the drive to Q166-Q176 180° out of phase with Q146-Q156. Again, the resultant output across the collector load (T174) is zero. However, both the upper and lower sidebands of the two input frequencies will appear across the primary winding of T174 and are coupled to the secondary and bandpass filter.

Bandpass Filter

The modulated output across T174 is coupled through the Bandpass Filter, to limit the bandpass of the signal to approximately 0.75 MHz above and below 3.58 MHz. L176 and L184 adjust the filter to a center frequency of 3.58 MHz.

The modulated subcarrier signal then drives the Chroma Output Amplifier.

BAR TIMING ⟨2⟩

Bar Oscillator

The active components for the Bar Oscillator circuit consist of Q206, Q216, and Q236. This circuit generates frequencies which, when divided down by counter circuits, produce timing information for composite blanking, line blanking, I, Q, and the color bar red, green, and blue signals.

The oscillator (Q206-Q216) is tuned to about 600 kHz by the collector load (L217-C218) for Q206. Q236 is the oscillator output stage. CR202 and CR206, in the tank circuit, limit the amplitude of oscillation.

Q216 and Q236 act as a current switch which generates a square wave output across R234 in the collector circuit of Q236. This square wave is at the oscillator rate.

Bar Oscillator Frequency Control

The Bar Oscillator Frequency control circuit controls the frequency of the Bar Oscillator.

With the FIELD DISPLAY switch set to EIA COLOR BARS position, a signal from the Color Bar Time Gate (see diagram 3) forward biases Q208, adding C207 and C208 across the Bar Oscillator tank circuit, reducing the oscillator frequency to approximately 525 kHz. After 3/4 of the active video line time, Q208 is reverse biased and a signal via the I, Q Time Gate (see diagram 3) forward biases Q228. C224 and C227 then shunt the oscillator tank circuit to reduce the oscillator frequency to approximately 420 kHz. (See Fig. 3-1.)

With the FIELD DISPLAY switch set to FULL FIELD COLOR BARS position, the frequency is as described for the Bar Oscillator; 600 kHz.

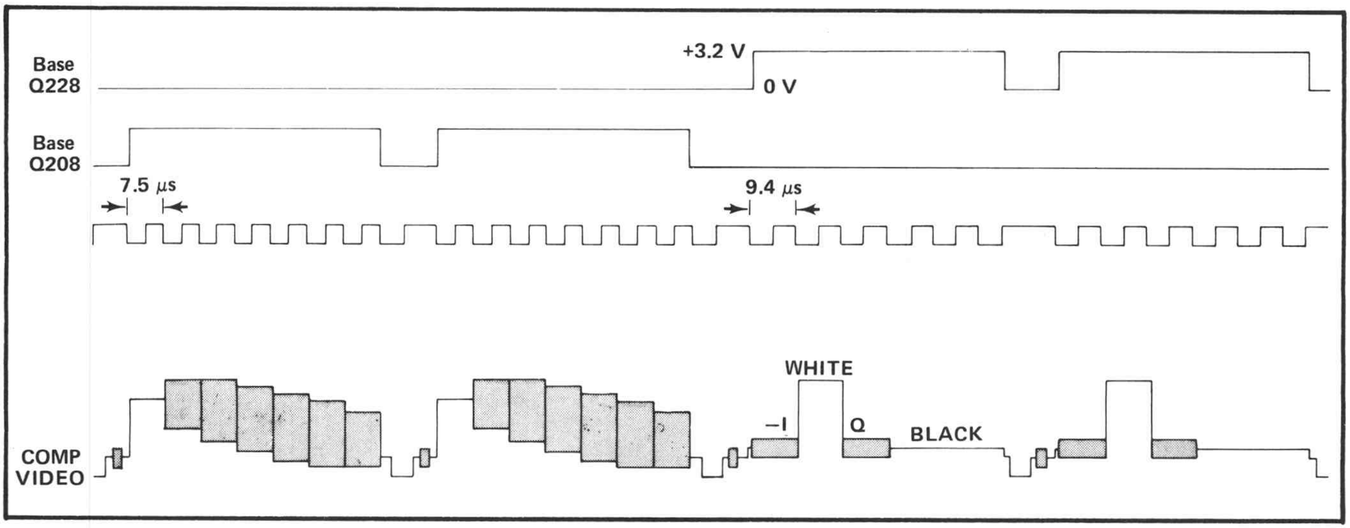


Fig. 3-1. Time-relation of waveforms to and from the Bar Oscillator in relation to the composite video signal in EIA COLOR BARS mode of operation.

÷ 4 Counter

The output frequency of the Bar Oscillator is divided down by a ÷ 4 Counter consisting of U243 and U245, connected as JK Flip-Flops. The output of the counter drives the Luminance Delay and Color Bar Counter and Logic stages.

Bar Oscillator Start-Stop Control

U253 and Q226 are the active components for the Bar Oscillator Start-Stop control circuit. The oscillator is gated off between the end of the blue chroma color bar and one cycle before the start of the white level bar by this circuit.

The Bar Oscillator start signal, from the line timing circuits, is coupled to pin 1 of a four input AND gate, U253. Q226 is reversed biased, permitting the oscillator to run. Various timing signals from the Color Bar Chroma Counter & Logic circuit hold Q226 at cutoff until the end of the blue chroma bar, at which time, all inputs to U253 are such that Q226 is again forward biased, disabling the oscillator.

Color Bar Chrominance Counter & Logic

U255, U257A, U265, U275, and U277 are the Color Bar Chrominance Counter & Logic elements. U255, U265, and U275 are connected as J-K Flip-Flops with preset inputs forming a synchronous counter.

This circuit performs the counting and logic functions which convert the oscillator ÷4 signals into related green, red, and blue chroma gate signals. The outputs are coupled to the Staircase Timing Logic, IQ Logic, and Bar Oscillator Start-Stop Control circuits.

IQ Chrominance Logic

U263, U273, U293B and U295 perform the IQ Chrominance Logic functions. These AND gates combine timing signals from the Color Bar Chroma Counter and Logic circuit to develop the I and Q Chrominance gates to drive the IQ Chrominance Amplitude stage.

IQ Chrominance Amplitude

This circuit uses the timing information from the IQ Chrominance Logic stage to gate various currents corresponding to the I and Q chrominance signal to drive the modulator filters.

Luminance Delay

The Luminance Delay circuit provides an adjustable delay between the luminance and chrominance signals.

The outputs from the ÷ 4 Counter are differentiated by an RC timing network consisting of C252, R235, and R238. R235 varies the RC Time constant of the network and sets the delay time.

The negative excursions of the differentiated pulse, at the base of Q237, turns the transistor off. When Q237 switches back on, some delay time later, it clocks the JK Flip Flops U258, U268, and U278. Duration of this period is determined by the width of the negative differentiated pulse; see Fig. 3-2.

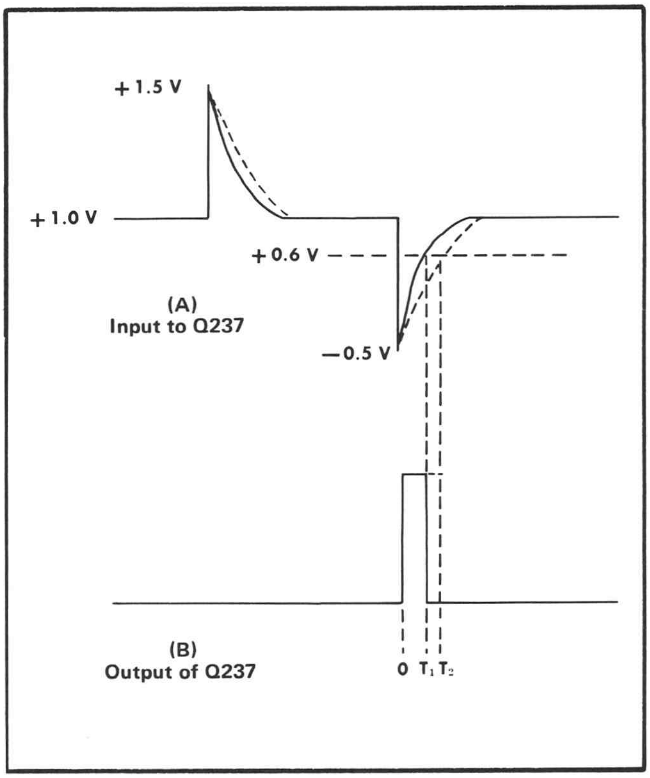


Fig. 3-2. Input and output waveforms for Q237. T_1 and T_2 are delay times with R235 set at each limit of adjustment.

Color Bar Luminance Counter & Logic

U257B, U258, U267, U268 and U278 comprise the Color Bar Luminance Counter & Logic circuit. This circuit is similar to the Color Bar Chrominance Counter & Logic circuit, except that luminance gates are generated corresponding to green, red and blue.

Output signals are coupled to the IQ Chrominance Logic, IQ White Drive, Color Bar Setup and Line Blanking and Color Bar Luminance Amplitude circuits.

IQ White Drive

The IQ White Drive circuit consists of U293A and U297. U297 is connected as a four-input AND gate, with the four inputs driven from various timing signals from the Color Bar Chroma and Luminance Counter & Logic circuits. The output signal is coupled to the IQ White Reference Amplitude circuit.

Color Bar Setup & Line Blanking

U298, a Set-Reset Flip-Flop, comprises the Color Bar Setup & Line Blanking circuit. The set signal originates in the Color Bar Luminance Counter & Logic circuit and the reset signal is a line rate pulse from the Line Counter circuit.

Color Bar and Setup Voltage Supplies

Q203, Q213, Q223 and Q233 serve as outputs for the voltages developed across the divider consisting of R201, R202, R213, R214 and R215. The output voltages are changed in accordance with the settings of the front-panel COLOR BARS AMPL and SETUP switches. The output voltages are coupled to the Color Bar Luminance Amplitude, Color Bar Chrominance Amplitude and IQ White Reference Amplitude stages.

FIELD TIMING ⟨3⟩

Circuits on the Field Timing board include the Field Counter, Field Logic, VITS Logic and Video Logic.

Field Counter

The Field Counter circuit consists of U301, U302, U304, U306, U308, U309, U321, U322, U324, U326, U328, U329 and U349A, Q311, Q312, Q314, Q316, Q317, Q318 and Q319.

The circuit is primarily a series of JK Flip-Flops, connected as a 525 state preset binary counter. The preset occurs at the beginning of video line 262. When Ext Comp Video is applied, the Field Preset pulse serves as a second preset signal coupled through Q311 to Q319 to the appropriate counters to preset the Field counter to video line 7. A 31.25 kHz square wave from the Line Counter is applied to pin 2 of U309 to start the counting sequence.

Output gates from the Field Counter are applied to the VITS Logic, Field Logic and Video Logic circuits. Time relation of these output gates is shown on the pull-out diagram labeled Field Timing Details at the back of the manual.

Field Logic

The Field Logic circuit includes U336, U338, U341, U342, U344, U346A, U348, U349B, U361, U362, U364 and U372A.

The circuit is driven from various timing signals originating in the Field Counter circuit. Timing signals are combined in multiple-input AND gates to develop set and reset input signals for Set-Reset Flip-Flops. Generation of the Keyout signal will be described as an example.

When the three inputs of U342, (pins 1, 2 and 5) are low, the output (pins 6 and 7) goes high. Since the lows are simultaneous for only a short time, the output is a positive pulse. This positive pulse is applied to the set input (pin 1)

on U362, the Keyout Gate. When the gate is set, the '1' output (pin 6) goes high. Later, when pins 3 and 5 on U344B are both low, pin 6 of U344B goes high. The high is applied to the reset input (pin 5) on U362, causing the '1' output (pin 6) to return low. The Keyout signal is therefore a positive pulse which starts when the set input of U362 goes high and ends when the reset input goes high. The Keyout signal is coupled to pin connector BA and hence to Comp Sync Logic and Burst Logic circuits.

A negative Keyout gate appears at the '0' output (pin 7) of U362. This signal is applied to U372A to combine with the '1' output of the Serration Gate, U364. When these two signals are low, a positive equalizer gate is generated at pin 7 of U372A.

Other signals generated in the Field Logic circuit include Vert Drive, Field Blanking and the set pulse for the Split Field Gate.

VITS Logic

The VITS Logic circuit includes U346B, U366, U368 and U369. U366 is connected as a Set-Reset Flip-Flop and the other active components are negative-input AND gates.

Fig. 3-3 illustrates the various signals related to VITS Logic in proper time-relation to each other. Note that nine different signals must be in the 'low' state to initiate the VITS gate.

Video Logic

The Video Logic stage encompasses several related circuits which determine whether the line video will be staircase or color bar, and if color bar, whether the signal will be EIA COLOR BARS, FULL FIELD COLOR BARS, or COLOR BARS/Y REF. Selection of the VITS signal (staircase or color bar) is also accomplished in this stage.

Operation of the Video Logic circuits depends upon the settings of the 146 FIELD DISPLAY, VIDEO, VITS SIGNAL, and APL/IRE LEVEL switches. Referring to Fig. 3-4 and diagram 3, the Video Logic consists of several negative input AND gates and several gates which operate as AND gates, but require one input low and the other high to obtain the desired output. (Outputs A and D require a high output; L, F, H, M, and R all require a low output.)

A positive level applied to the Video Enable Drive stage from the Field Sync Logic circuit provides a phantom ground (low) which is applied to the Setup Field Drive, VITS Staircase Enable, Vits Color Bar Enable, Color Bar Field Drive, I, Q Field Drive, IQ Time Gate, and the Color Bar Time Gate. Without this low it is impossible to obtain a composite video signal at the COMP VIDEO connectors.

APL Logic, Field Blanking, VITS Enable and Field Logic also drive these gates, and at various times, all inputs to a particular gate are such that the desired output is obtained. The output is then used to drive or enable other circuits within the 146 which produce the composite video output signal obtained at the COMP VIDEO connectors.

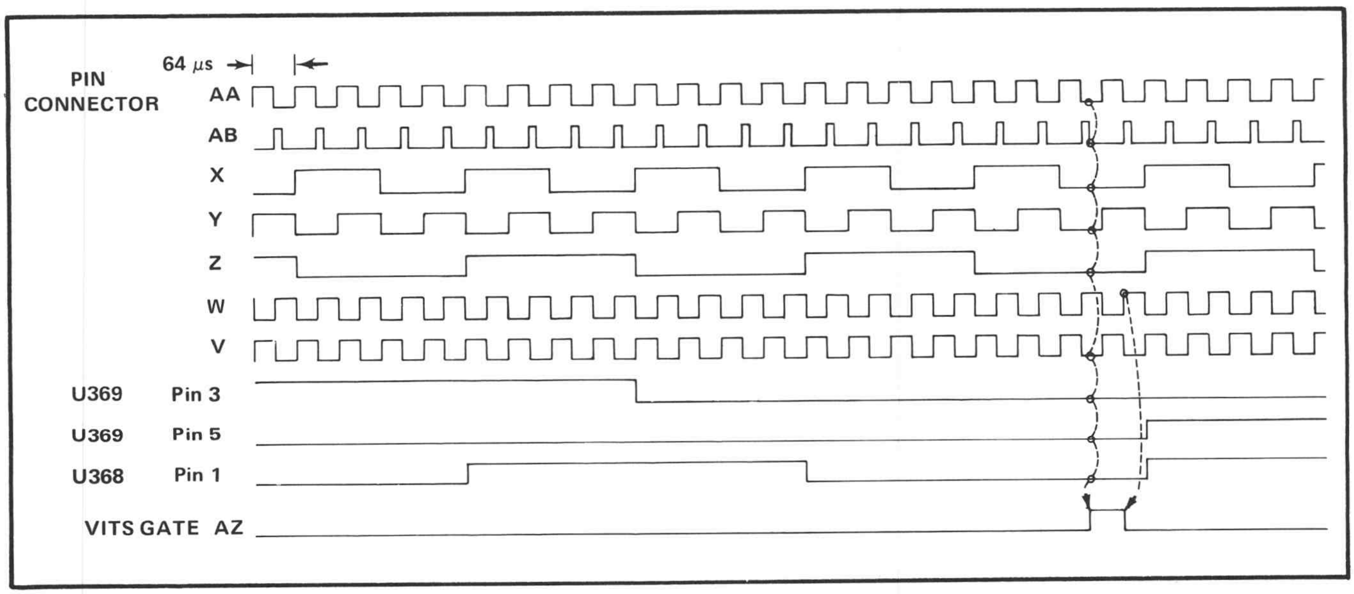


Fig. 3-3. VITS Logic input, output and related waveforms. VITS selected is Line 20, Field 2.

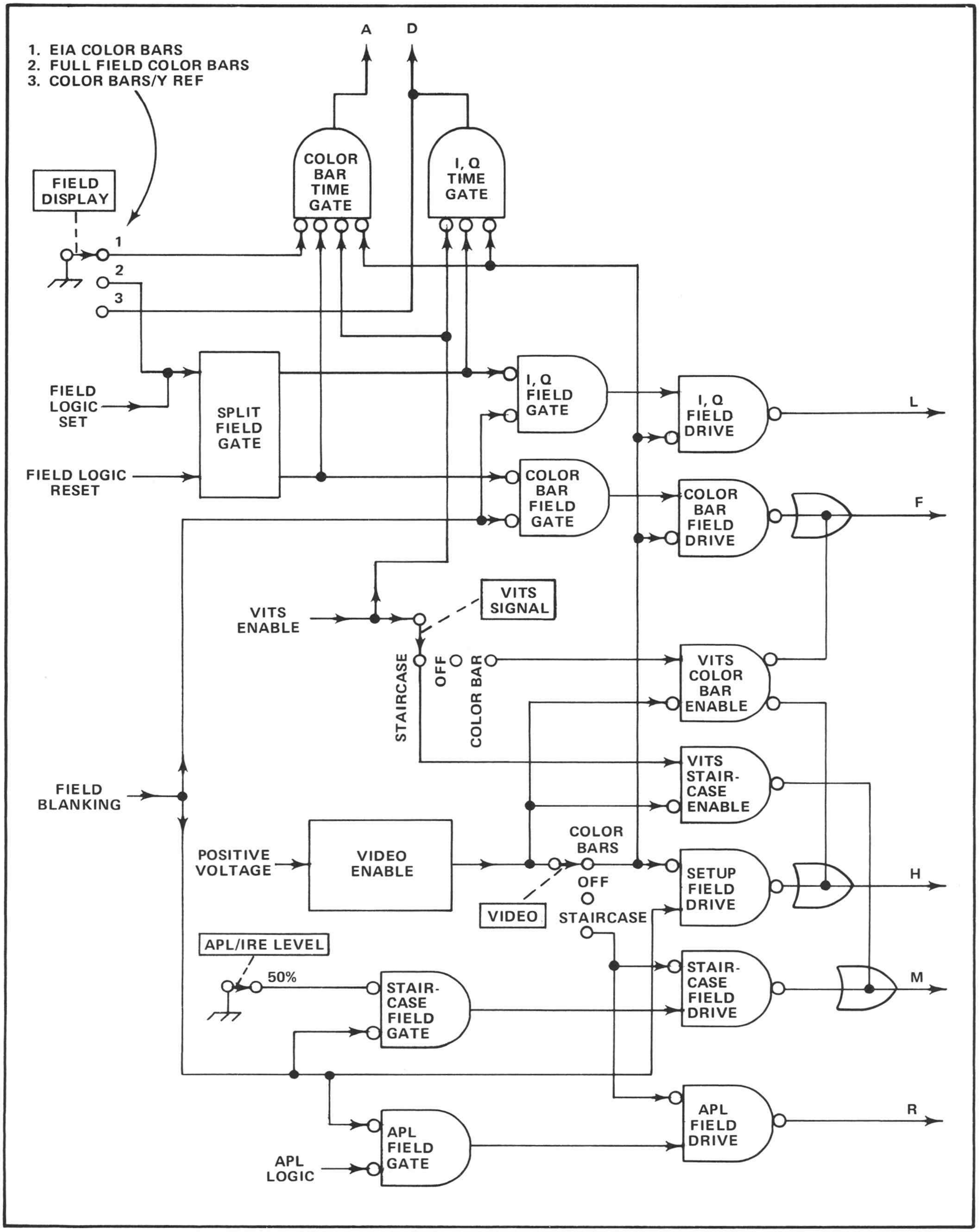


Fig. 3-4. Block diagram of Video Logic Circuits with logic symbols.

APL Logic

The APL Logic circuit includes U372B, U374, U376, U378 and U379, serving as a divide-by-five counter. U374, U376 and U379 are connected as JK Flip-Flops.

In the 50% position of the APL switch, pin 7 of U379 is grounded (low). In all other positions of the APL switch, pin 7 of U379 is low for one line, while pin 5 is low for four lines. Pin 7 is coupled to the Staircase Field Gate and pin 5 is coupled to the APL Field Gate.. This circuit accomplishes the four lines of APL and one line of staircase display mode.

U372B supplies the preset pulse for the divide-by-five counter.

COLOR BAR DRIVE ⟨4a⟩

Color Bar Chrominance Amplitude

The Color Bar Chrominance Amplitude circuit consists of Q400, Q402, Q403, Q406, Q407, Q408, Q420, Q422, Q423, Q426, Q427, and Q428. In this circuit, the amplitude of the red, green, and blue components of the ± (R−Y) and ± (B−Y) signals are set to industry standards. The circuit consists of 6 similar stages. Each of the three colors has an individual switching stage for the B−Y and R−Y components. Since the stages are similar, the blue amplitude-setting stage for the + (B−Y) signal will be described as an example.

The blue chrominance drive signal (pin W), from the Color Bar Chrominance Counter and Logic circuit, is applied to the base of Q428. The negative going signal drives Q428 into cutoff during each pulse. The current through Q428 is now diverted through Q408. R419 is adjusted to calibrate the blue component for the + (B−Y) signal magnitude.

Color bar voltages are set by the front-panel COLOR BARS AMPL and SETUP switches. (See diagram 2.)

C427 compensates for any time difference between the + (B−Y) and − (B−Y) signals and is adjusted so they are coincident.

During the vertical blanking interval, CR406 is forward biased, diverting the blue signal current through R427. The blue chrominance drive signal is also coupled to the base of Q420 and hence through an amplifier circuit similar to that just described to form the − (R−Y) component of the blue chrominance signal.

Burst Amplitude

Q404, Q424 and CR425 comprise the Burst Amplitude circuit. This circuit consists of a switching pair stage which is very similar to the Color Bar Chroma Amplitude stage previously described.

When the front-panel BURST switch is in the 'off' position (down), the burst signal current is diverted through CR425 to the +3.6 V supply.

VIDEO OUT ⟨4b⟩

The Video Out diagram contains circuits which include the Color Bar Luminance Amplitude, I, Q White Reference Amplitude, Wide Band Filter, Narrow Band Filter, Luminance Output Amplifier, Chrominance Enable and Chrominance Output Amplifier.

Color Bar Luminance Amplitude

The Color Bar Luminance Amplitude circuit includes Q434, Q436, Q441, Q443, Q445, Q450 through Q456, Q463 and Q465. The Color Bar luminance amplitude is set by the calibration adjustments in the emitter load of each emitter follower that drives current amplifiers Q455, Q456, Q445 and Q465.

The red, blue and green amplitude-setting stages, white reference and setup level stages are similar in operation, therefore, a description of the green amplitude-setting stage will describe the operation of all these circuits.

The incoming green luminance signal (negative polarity) turns Q463 off, diverting the current of the emitter load resistors R465, R454 through Q465. Amplitude of the current is determined by the setting of R454. C465 compensates for unequal delays in the rise and fall of the signal.

When the front-panel Y switch is set to the off position (down), the signal current is shunted to the +3.6 V supply through CR462, R452 and R462. With the Y switch set to 'on' (up), the color bar field drive signal (delayed by R452 and C452 to match the chroma delay) reverse biases CR462, permitting the normal signal current to flow through Q465. During the vertical blanking interval, (except during a color bar VITS signal) CR462 is forward biased, diverting the signal current to the +3.6 V supply.

I, Q White Reference Amplitude

Q431, Q433 and Q435 comprise the I, Q White Reference Amplitude circuit. This circuit is similar to the Color Bar Luminance Amplitude stages previously described

except for the variable voltage supplied by Q431 to the negative end of the current-setting resistors R444 and R434. The I, Q white line drive signal to the base of Q433 cuts the transistor off during the white bar portion of the —I, W, Q, B signal, diverting the current through Q435. R434 in the common-emitter circuit sets the magnitude of the current, providing a calibration adjustment.

Q431 provides the voltage source for the gain setting resistors R434, R444. Any change in the setup supply voltage causes the emitter reference to shift, maintaining a constant output reference current through the resistors for all setup levels.

The I, Q White Reference signal is coupled through Q435 and R436 to the emitter of Q447. When the VIDEO switch is set to MOD STAIRCASE, the staircase luminance signal is also applied to the emitter of Q447 where the two signals are mixed.

Wide Band Filter

The color bar luminance levels and composite sync signal are coupled through Q446 to the Wide Band Filter, L456-C456 and L466, C467, C478. Q446 serves as a constant-current signal source to drive the filter. R457 is the termination for the filter. The filter response has a rise-time of 115 ns and is $\sin^2$ shaped.

Response of the wide band filter has been selected to provide color bar luminance steps extending to the allowable system bandwidth.

Narrow Band Filter

The I, Q white reference level and staircase luminance signals are coupled through Q447 to the Narrow Band Filter, L458-C459 and L468-C468, C469. The filter response risetime is 260 ns and is $\sin^2$ shaped. The function of the filter is to minimize step harmonics which may fall in the chrominance band.

Luminance Output Amplifier

The Luminance Output Amplifier, consisting of Q476, Q477, Q478 and Q487, is an operational amplifier circuit. Characteristically, the input impedance is very low and the signal voltage at the emitter of Q478 will be only a few millivolts in amplitude.

R_f for the amplifier consists of R467 and R499. Adjustment of R499 sets the gain of the stage, providing a calibrated luminance amplitude at the output connector.

R478 sets the output DC level of the amplifier.

Q476 sets the emitter voltage of Q477 and provides temperature compensation for Q477. CR479 in the base circuit of Q478 provides temperature compensation to Q478.

The amplified luminance signal is connected through R488 and R497 to the rear- and front-panel COMP VIDEO connectors as well as pin F, which is not used at this time.

K495 connects the output signals from the luminance and chrominance output amplifiers to the output connectors when the instrument is energized. When the instrument is turned off, contacts on K495 remove the connections between the output amplifiers and the output connectors, and then connect the output connectors through R487 and R496 to ground. This assures that any cables connected to the output connectors are always terminated in 75 ohms, whether the instrument power is on or off.

Chrominance Enable

The Chrominance Enable circuit includes Q471, Q481 and Q491. When a subcarrier signal is present, a negative voltage, developed in the Subcarrier Lamp & Switching circuitry, forward biases Q471 into saturation. With Q471 in saturation, the divider consisting of R461, R471 and R491 reverse biases Q481. Q491 is then reverse biased through R490, so no subcarrier signal current can flow through C491 and Q491 to ground. C491 is a 3 volt capacitor which supplies leakage current to maintain the collector-base junction of Q491 in a reverse bias condition.

Chrominance Output Amplifier

The Chrominance Output Amplifier consisting of Q473, Q474, Q475 and Q484, is an operational amplifier very similar to the Luminance Output Amplifier previously described.

The chrominance signal at pin connector BA is applied to the emitter of Q473 through R481, which serves as R_i for the amplifier. R_f consists of R473 and R482. Adjustment of R482 sets the gain of the stage to provide a calibrated chrominance amplitude at the output connectors.

Luminance and chrominance signals are combined into a composite signal at the output connectors. The combinations of R488-R494 and R495-R497 provide impedance of 75 Ω to each respective output connector.

Separate output amplifiers for luminance and chrominance are used in order to minimize differential phase and differential gain. If a common output amplifier were used, changes in the luminance signal could cause changes in the instantaneous operating level of the amplifier stages, introducing differential distortion to the chrominance signal.

STAIRCASE ⟨5⟩

Staircase Timing Logic

The Staircase Timing Logic consists of U507 through U558. This circuitry, a series of gates and set-reset flip-flops, generates gating pulses of various widths to drive the Staircase Luminance Amplitude, APL Chroma, and Staircase Chroma Amplitude stages.

Staircase Luminance Amplitude

Six transistor switching pairs, Q514-Q516, Q523-Q525, Q524-Q526, Q533-Q535, Q524-Q536, and Q553-Q555 form this stage.

Each switching pair is identical except for the emitter resistance of Q514-Q516 and Q553-Q555. The current from each pair is summed (added) at a common point to produce the desired staircase signal current. This signal current is applied to the Wide Band Filter (see diagram 4b) for further processing.

With the STEPS switch (S48) in the 10 step position, Q516 is reversed biased and current via Q514 is available at the summing point. Magnitude of this current is set by R562. Approximately 3.3 µs later, Q555 is biased off and current via Q553 is added to the current, of Q514, to form the second step of the staircase signal current. 3.3 µs later, Q555 is again forward biased. This would decrease the staircase amplitude, but at this time, Q525 is reversed biased and current via Q523 is added to the current, of Q514, to form the third step. This process continues for the entire 10 step staircase signal. With the STEP switch in the 5 step position, Q516 and Q555 are reversed biased at all times to produce the first step of the staircase signal.

Fig. 3-5 shows the various time related signals required to produce the 10 and 5 step staircase luminance signal.

APL Luminance Amplitude

The APL Amplitude circuit consists of Q543, Q545 and the front-panel APL/IRE LEVEL switch.

The line blanking signal diverts the current which normally flows through Q545 to Q543. Magnitude of the current is determined by the setting of S54 (APL), which selects the emitter series resistance for Q545.

The resulting current from Q543 is applied through R535 and adds to the staircase step currents at the summing point.

Staircase Chroma Amplitude

Q532 and Q542 comprise the Staircase Chroma Amplitude circuit. The operation of this circuit is similar to the APL Amplitude circuit previously described.

A negative gate, from the Staircase Timing Logic circuit, is applied to the base of Q542, diverting the current from R551 and R561 through Q532. When the 180° SUBCARRIER switch is in the 'off' position (down), the current flows through CR542 and R542 to the +3.6 V supply. When the switch is in the 'on' position (up), CR542 is reversed biased permitting the current to be diverted through Q532 during the gate. The magnitude of the current is set by R561. The output current is applied through R541 to pin connector AJ and hence to the B—Y Filter and Modulator.

APL Chrominance

The APL Chrominance circuit consists of Q501, Q502, Q503, Q511, Q512, Q513, Q522 and Q531. This circuit is a current switch that operates the same as the Staircase Chroma Amplitude and APL Amplitude previously described.

In the OFF position of the 90° SUBCARRIER switch, CR511, CR513 and CR522 are turned on which shunts the current through the gain setting resistors to +3.6 V supply and disables the APL Chrominance circuits.

When the 90° SUBCARRIER switch is set to the UNMOD position, the APL Field Drive signal reverse biases CR511 for the duration of the negative gate. This permits current flow through Q511, providing a low-level offset chrominance during the APL lines.

When the 90° SUBCARRIER switch is set to the MOD position, the APL Field Drive signal reverse biases CR513 and CR522, permitting current flow through Q531 and Q522. Signals from the Staircase Timing Logic circuit divert current from Q503 and Q513 to Q531, while other Staircase Timing Logic signals divert current from Q502 and Q512 to Q522. Simultaneously, CR521 is reversed biased, changing the voltage division across the divider (R512, CR512 and R521). This turns off CR511 permitting current flow through Q511.

Fig. 3-6 shows the time relation between the input gates, the output waveform of APL Chroma and the video output waveform.

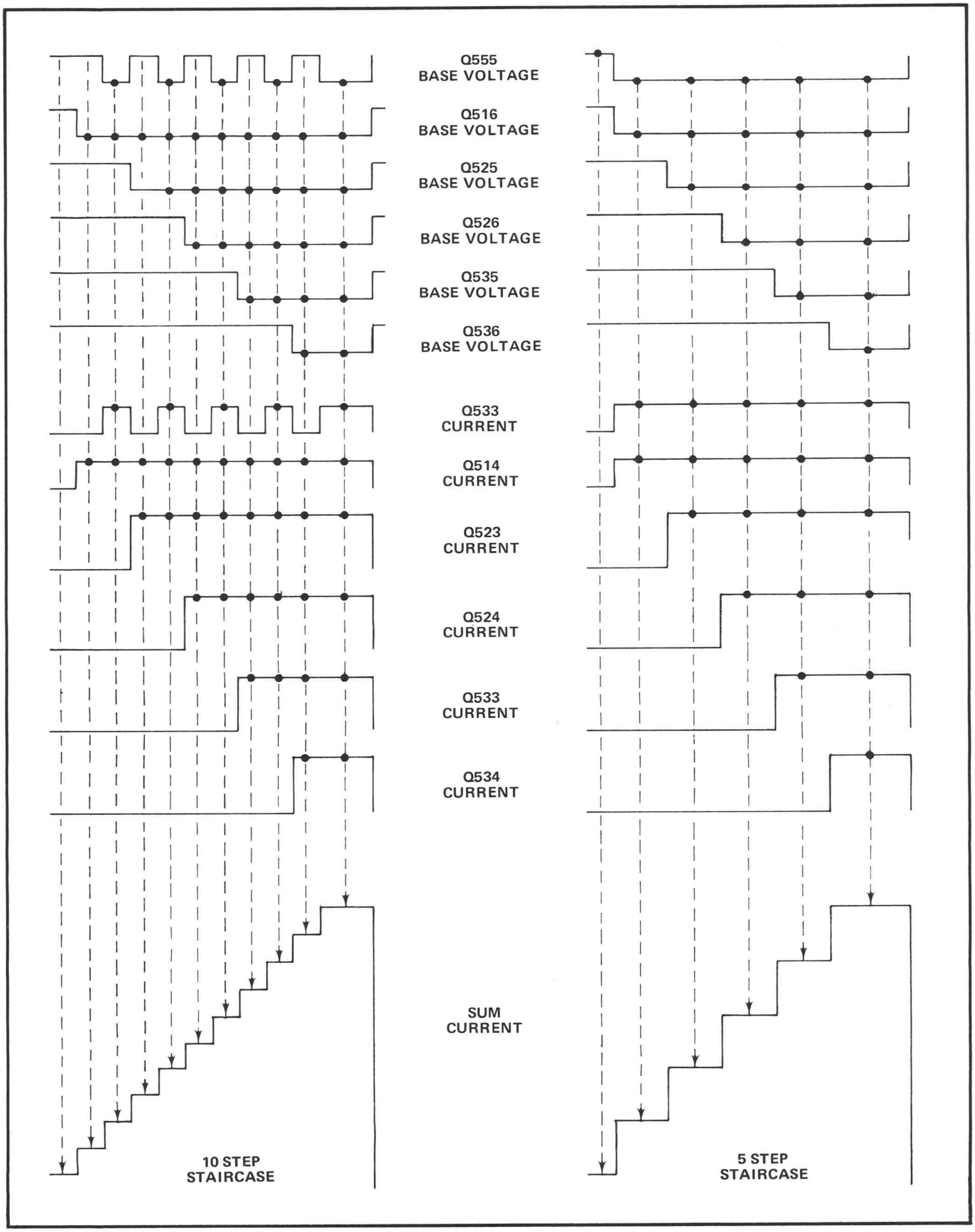


Fig. 3-5. Time related signals necessary to produce the 10 or 5 step staircase test signal.

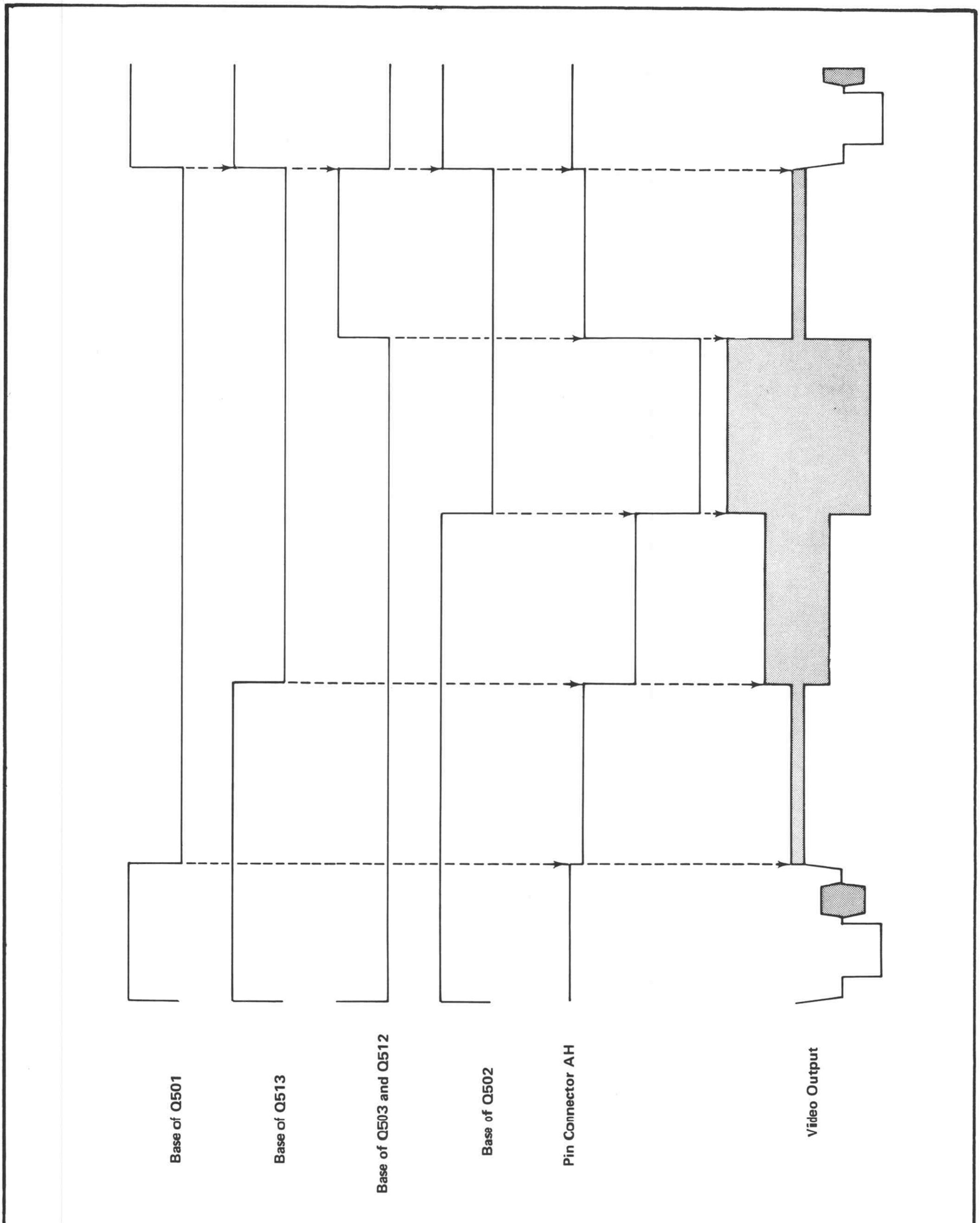


Fig. 3-6. Input and output waveforms for the APL Chroma circuit shown in relation to VIDEO OUT.

Comp Sync Amplitude

Q544 and Q546 comprise the Comp Sync Amplitude circuit. This circuit is a current switch pair, similar to APL Amplitude, etc.

The composite sync signal at pin connector T is negative-going and turns Q546 off which diverts the current to Q544. R567 sets the magnitude of the signal current. The adjusted signal is applied through R544 to pin connector AM. When the SYNC signal is absent, Q544 is turned off, which maintains the output blanking level at 0 V instead of shifting it to the sync tip voltage level.

LINE TIMING 6a

The Line Frequency Control Oscillator, Line Counter, Bar Oscillator Start & Bar Preset, Composite Sync Logic, Horiz Drive Logic, Burst Logic, Sample Logic, and Line Detail Timing circuits compose the Line Timing circuitry.

Since most of the Line Timing circuitry consists of flip-flops and gates which set the timing sequence, only the Line Frequency Control Oscillator, Line Counter, and Line Detail Timing circuits will be described.

Line Frequency Control Oscillator

The oscillator consisting of Q643, Q644, Y643, and CR643, is a modified Colpitts, with CR643 (a voltage variable capacitance diode) to alter the frequency of the oscillator in relation to a DC error signal voltage from the Phase Lock Sampler in the LINE SYNC Logic circuit.

Q644 supplies the in phase feedback to the oscillator and also serves as the output driving stage. The output signal is a clipped sine wave at approximately 1 MHz rate which drives the Line Counter.

Line Counter

The Line Counter consists of decade counters and inverters U615, U616B, U617, U626, U627, U629, U636, U637, and U639. This circuit counts down the oscillator frequency and provides signals at the horizontal line rate and subharmonic related signals to gate or operate other circuits in the 146.

Line Detail Timing

The Line Detail Timing circuit consists of U616A, Q692, Q621, Q622, Q691, Q682, Q672, Q662, Q652, and Q642. This circuitry provides signals to the Comp sync Logic circuit, which controls horizontal sync start and stop, equalizer stop, burst start-stop functions, and a signal to permit adjustment of coincidence between the internally generated sync and an externally applied sync signal.

A symmetrical square wave, twice the horizontal line rate, is inverted by U616A to drive Miller Integrator Q621 and Q622. C622 and R622 are the timing components. The output of the Miller Integrator is a trapezoidal waveform.

Fig. 3-7 illustrates the operation of the horizontal sync start circuit (Q691). Q692 provides temperature compensation for the Miller Integrator and the other transistors in this circuitry.

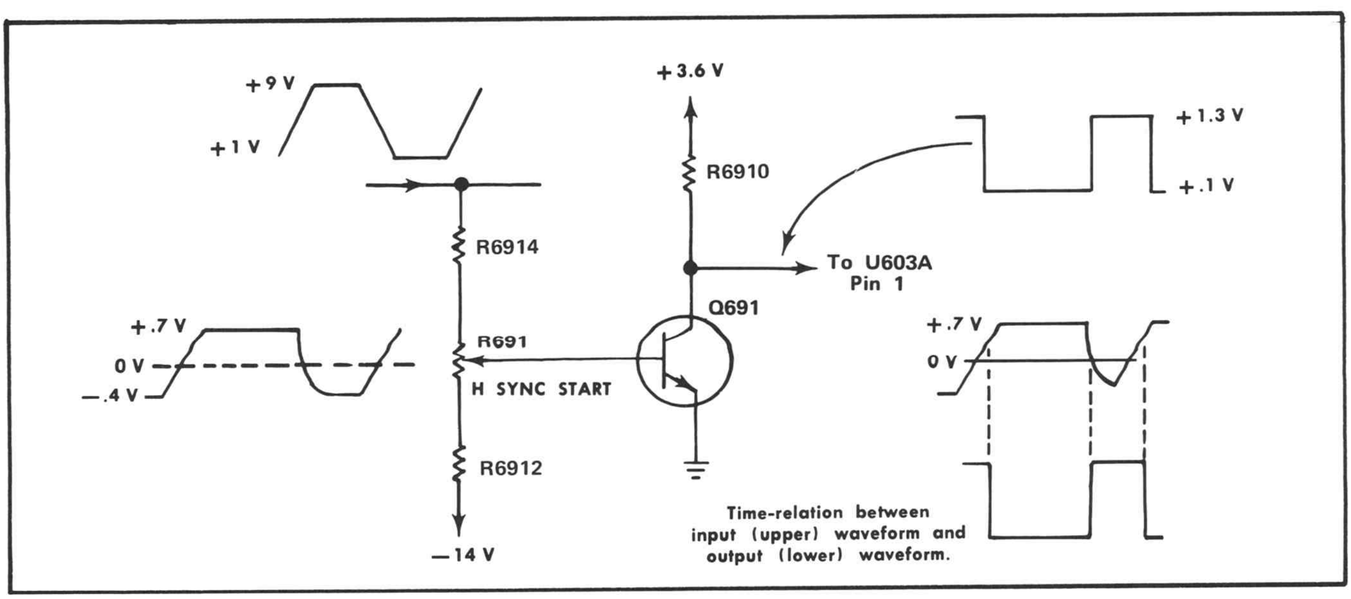


Fig. 3-7. H Sync Start circuit. Adjustment of R691 will select the point on the input ramp at which Q691 turns on, thus adjusting the time when the negative-going transition at the output occurs.

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LINE SYNC LOGIC 6b

The Line Sync Logic includes the 15 kHz Phased Lock Multivibrator, Limiting Ramp Generator, Int-Ext Sync Ref Switch, Phase Lock Reference Amplifier, Phase Lock Sampler, DC Control Loop Amplifier, Unlock Detector, and the Line Preset Gate circuitry.

The circuitry is used to provide proper timing information to the Line Timing circuitry. A block diagram of the Line Sync Logic is shown in Fig. 3-8 which is an aid for the description that follows.

15 kHz Phased Lock Multivibrator

Composite sync is differentiated by C6662 and R6662 and clamped at +0.6 V by CR6662. The negative portion of the differentiated signal triggers the astable multivibrator Q666 and Q667. Zener diode VR666 couples the initial transition to the base of Q667. C662 and R6660 are the frequency determining constants, setting frequency at approximately 15 kHz.

The output, a square wave, is applied to the Limiting Ramp Generator.

Limiting Ramp Generator

When Q557 turns on, it turns off Q669, which forward biases Q668 charging C669 towards +10 volts. The base voltage of Q668 limits the charge to approximately 5 volts. When the multivibrator flops back to quiescent state, C669 discharges through R669 to develop a negative-going ramp at TP668. The ramp is used to drive the Phase Lock Reference Amplifier and the Line Preset Gate.

Int-Ext Sync Switch

Q667 and Q676, connected as a current switch, allow either the internal subcarrier or the external sync to control the internal line counter.

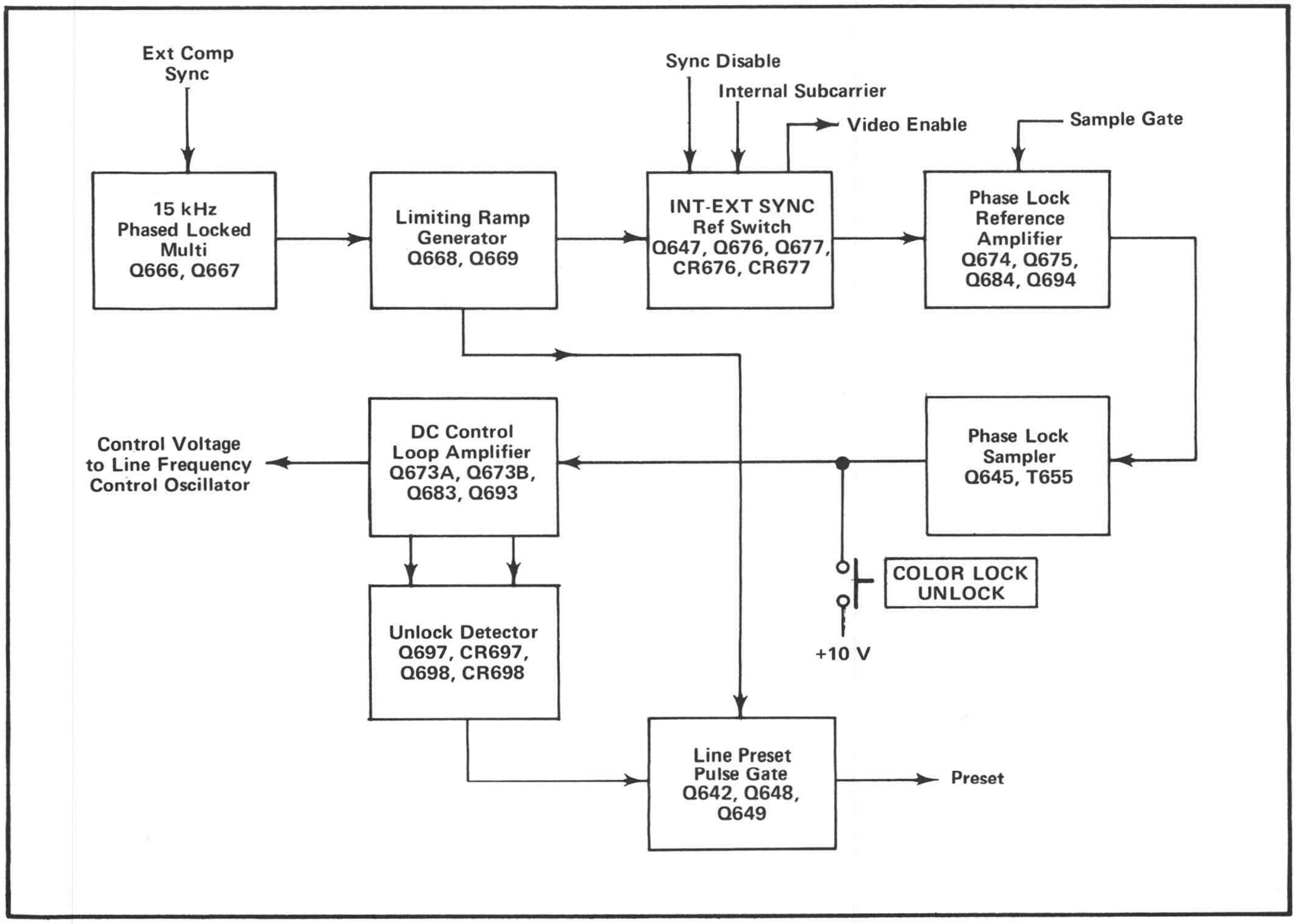

Fig. 3-8. Block diagram of Line Sync Logic.

With INT mode of operation, a sync lock disable pulse into Q647 grounds the base of Q676 and switches Q676 on, Q677 off. This allows CR677 to pass the internal subcarrier to the Phase Lock Reference Amplifier.

In the GEN LOCK mode, Q676 is turned off allowing CR676 to pass the ramp via the Ramp Generator to drive the Phase Lock Reference Amplifier.

Phase Lock Reference Amplifier

Q674, Q675, Q684, and Q694 are connected as an operational amplifier. R6742 is the feedback resistor. Q694 sets the emitter of Q684 to a constant voltage of about +5 volts. The output of the Operational amplifier drives the Phase Lock Sampler.

Phase Lock Sampler

Q645 and T655 form the Phase Lock Sampler. This circuit samples the signal from either the internal subcarrier oscillator or the integrated composite sync to produce a DC control voltage which is used to phase lock the Line Frequency Control Oscillator.

Positive pulses from the Line Timing circuits, occurring at one-half the line rate (7867 Hz) when sampling internal subcarrier, or occurring at the line rate (15734 Hz) when sampling external composite sync, drive the base of Q645. Q645 is reverse biased by these pulses, which allows the primary field of T655 to collapse. CR654 and CR664 become forward biased and charge memory capacitors C6540 and C6640 to the sampled voltage from the emitter of Q674. When Q645 turns on, the diodes are cut off and the voltage at TP663 will be the average voltage across the memory capacitors, or the sampled voltage.

Fig. 3-9 shows the output voltage obtained from the Phase Lock Sampler using internal subcarrier with (a) no error and (b) subcarrier too slow. The DC output voltage from the Phase Lock Sampler drives the DC Control Loop Amplifier.

DC Control Loop Amplifier

Q673A, Q673B, Q683, and Q693 comprise the DC Control Loop Amplifier. To provide minimum loading of the Phase Lock Amplifier, a FET (Q673A) is used as the input stage. The output of the source follower drives differential comparator Q683 and Q693. Q673B provides a temperature compensation and sets a DC reference level for the comparator. C6834 limits the bandwidth of the amplifier to stabilize the control loop. R6836 and C6836 decrease the loop gain at medium frequencies to increase noise immunity.

S68, the front-panel COLOR LOCK UNLOCK switch, when pressed allows the internal generator to free run for test purposes. The output of the amplifier drives the Unlock Detector circuit and controls the Line Frequency Control Oscillator.

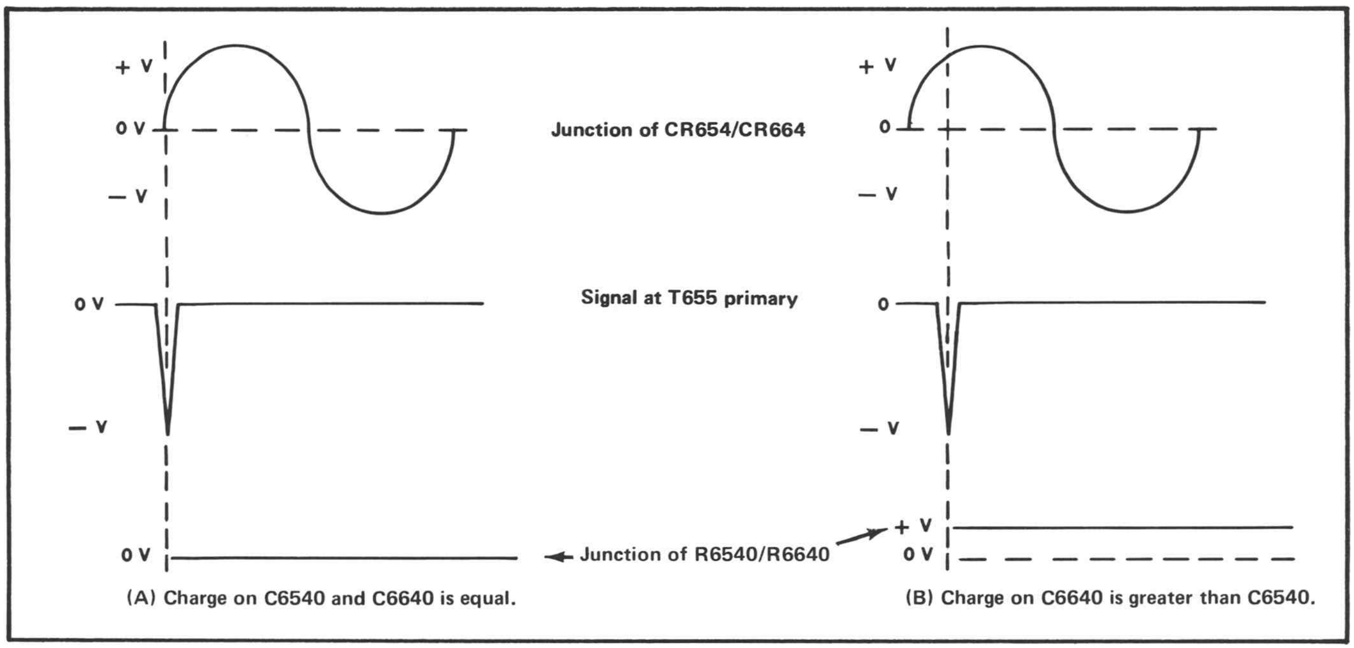

Fig. 3-9. (A) Action of Phase Lock Sampler at balance and (B) when unbalanced. In example (B), frequency of the Line Frequency Control Oscillator is too low and the Voltage level at the junction of R6540 and R6640 will cause the oscillator frequency to increase.

Unlock Detector

The Unlock Detector consists of Q697 and Q698. This circuit detects any phase error (or lack of sync) sensed by the Phase Lock Sampler and produces a pulse which controls the Line Preset Gate.

Both transistors are normally on with CR697 and CR698 off. If external sync is interrupted for any reason, when operating in the GEN LOCK mode, it will be sensed by the Phase Lock Sampler, amplified by the DC Control Loop Amplifier and either Q697 or Q698 will be turned off. With Q697 or Q698 off, a positive pulse is obtained which forward biases CR697 or CR698 to drive the Line Preset Gate.

Line Preset Gate

Q646, Q648, and Q649 are the active elements of the Line Preset Gate. This circuitry presets the Line Counter, during initial gen lock attempt, allowing the generator to become locked within the time of 1 line.

If external composite sync is interrupted, the positive pulse from the Unlock Detector turns Q646 on, which produces a negative pulse or gate at its collector. This forward biases CR646 which (1) reverse biases CR6471 to allow the AUTO INT SYNC light to light, (2) turns Q676 on, which switches the Int-Ext Sync switch allowing subcarrier to be substituted for the interrupted sync, and (3) disables U625 (see diagram 6a) allowing the Phase Lock Sampler to sample subcarrier.

When the external composite sync is returned, it is instantly applied to the base of Q648 via the Limiting Ramp Generator. Q648, normally off, is switched on. (Q648 operates as a two input AND gate and requires a low at its emitter and a high at its base to switch it on.) As Q648 is switched on, Q649 is turned on and a positive gate is obtained at its collector. This positive gate is differentiated by C649 and R649 and is used to preset the Line Counter.

CROSSHATCH and DOT GENERATOR ⟨7⟩

The Crosshatch and Dot generator circuit develops the CONVERGENCE PATTERN output signal. The diagram shows 3 basically separated circuits; the horizontal and field generators, and the output amplifier.

Horizontal Timing Generator

The Horizontal Generator includes Q751, Q752, Q761, Q762, Q776, Q784, Q793, Q794, Q796, U775, U785A, and U785B.

During line unblanking time, Q761 is biased off and its collector is at a positive level set by current from Q751 through the HORIZONTAL POSITION control, charging C761 to the same level.

Upon arrival of the positive-going line blanking signal from the Bar Timing Circuit, Q761 saturates, reverse biasing Q762 with the preset voltage on C761. Q752 is a constant-current source which discharges C761 at a linear rate. Q762 turns on when the voltage on C761 reaches its Vbe. Therefore, the HORIZONTAL POSITION control setting determines how long Q762 is cut off after the arrival of the line blanking signal. CR762 prevents Q762 from reaching saturation during conduction, so that turn-off is rapid.

With Q762 biased off, Q793 is forward biased which disables the oscillator (Q783-Q794). When the positive gate at the collector of Q762 ends, Q793 is reverse-biased, which allows the oscillator to run. CR781 limits the negative excursions at the output of the oscillator tank and CR791 provides temperature compensation for the circuit.

The duration of the positive gate from Q762's collector is always less than the period of line blanking, so that the oscillation commences before the end of line blanking. When oscillation starts, vertical crosshatch lines or dots are generated. Since the HORIZ POSITION control setting determines when the oscillation starts with relation to line blanking, this will also determine the horizontal position of the crosshatch lines or dots during the active part of the television line.

Q784 and Q794 are connected as a current switch, with the emitter currents flowing through R794. R764 and C783 form a decoupling network for the +10 V supply. During the negative half-cycle of oscillation, current increases through Q794, shutting off Q784. During the positive half-cycle of oscillation, Q784 is conducting while Q794 is off. At the collector of Q784, the signal is basically a square wave in shape, with the negative-going excursions serving as a clock signal for the flipflop U775.

U775 is connected as a preset triggered counter stage. The counter is preset by the positive gate at the collector of Q762. This gate is coupled through R772 to pin 6 of U775. The counter divides the input trigger rate by two. That is, the output signal at pin 5 or pin 7 is one-half the input trigger rate. Pin 5 output signal is applied to U785A to develop the horizontal timing component of the dot pattern. The negative gate at pin 5 is also coupled back through R754 to the base of Q784 to stretch the time during which pin 5 is held low. The output signals at pins 5 and 7 are non-symmetrical, with the negative gate at pin 5 longer in duration than the negative gate at pin 7. This difference is necessary to achieve proper interlace of dots

and crosshatch signals when operating the DISPLAY switch in the BOTH position.

C764 and R774 (base of Q784) time-constant prevents the leading edge of the positive gate from pin 5 of U775 from initiating a double trigger.

With the DISPLAY switch set to BOTH, the negative gate at pin 5 of U775 is inverted by U785A. The resulting positive gate is differentiated by C785 and R765. The positive portion of this differentiated signal reverse-biases Q786 for 350 ns, providing a negative pulse at the collector and TP766.

The negative gate at pin 7 of U775 is inverted by U785B resulting in a positive gate at the base of Q796. The positive gate thus appearing at the emitter of Q796 is differentiated by C795 and R775 which produces a 250 ns positive pulse that is coupled through Q776 (a grounded base stage) to TP776.

Refer to Fig. 3-10 for time-related waveforms for the Horizontal Generator.

When the DISPLAY switch is set to CROSSHATCH, +3.6 V is applied to pin 1 of U785A, preventing generation of the dot pattern. In the DOT position of the DISPLAY

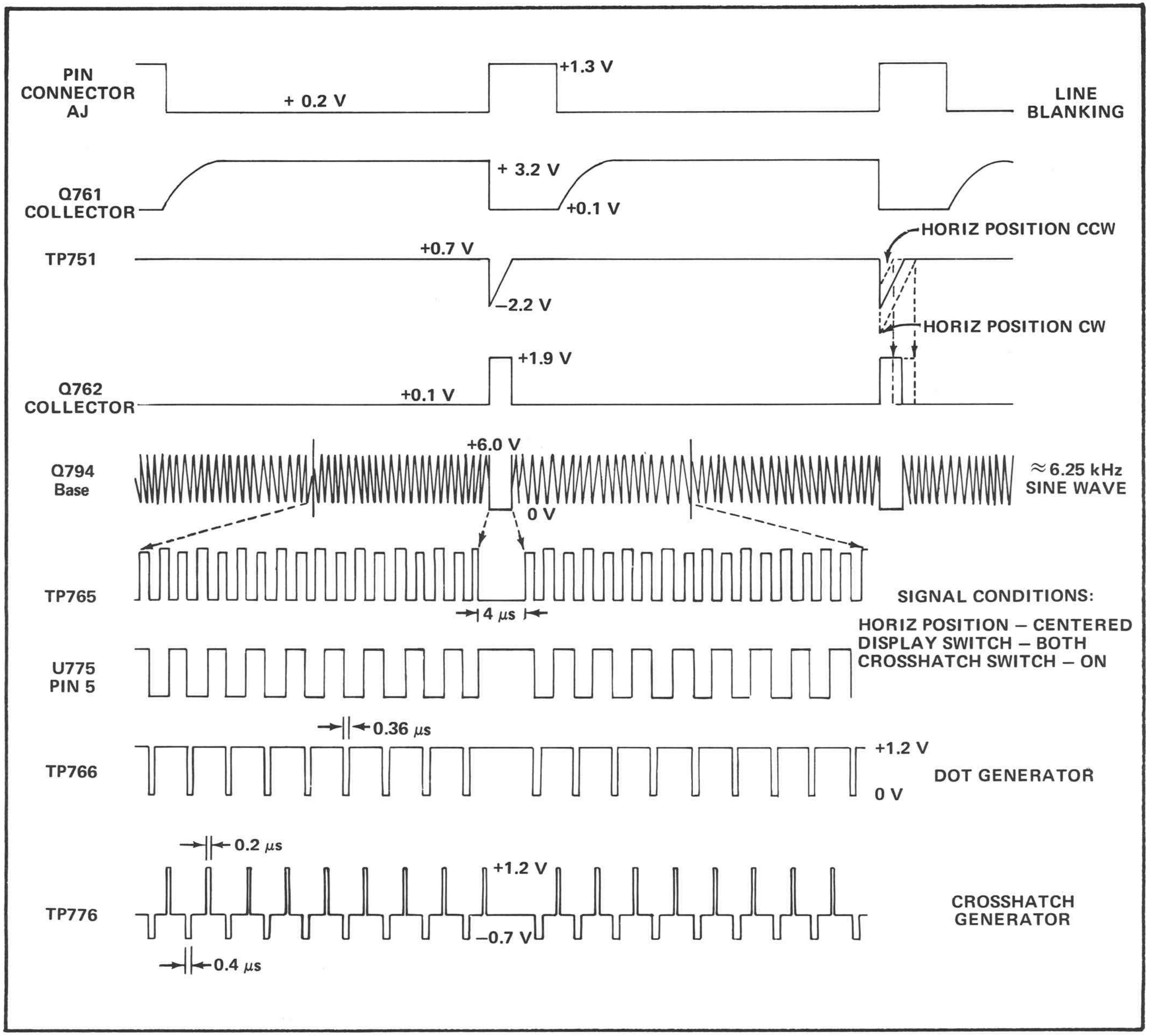

Fig. 3-10. Time-related sequential waveforms in the Vertical Generator of the Crosshatch and Dot Generator. Time scale of bottom 3 waveforms is 2 times the rate of the others.

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switch, +3.6 V is applied through CR784 to pin 5 of U785B, preventing generation of the vertical crosshatch component. +3.6 V is also applied through CR794 to pin 3 of U732, which disables the horizontal crosshatch component.

The CROSSHATCH switch disables the horizontal crosshatch generator when set to VERT by applying +3.6 V to pin 3 of U732. In the HORIZ position, +3.6 V is applied to pin 5 of U785B, disabling the vertical crosshatch generator.

Field Timing Generator

The Field Timing Generator includes Q704, Q705, Q714, Q715, U711, U712, U721 through U725, U731, U734, U741, U742, U743A, and U744.

The circuit is basically a counter which counts down from the line blanking signal at a ratio of 35:1. The counter is preset by a positive gate which is initiated by the vertical blanking signal. Width of the preset gate is determined by the setting of the VERT POSITION control.

The vertical blanking signal at pin connector X is a positive gate to the base of Q714. The VERT POSITION circuit is very much like the HORIZ POSITION circuit previously described. A negative sawtooth appears at the base of Q715, with the sawtooth determined by the setting of the VERT POSITION control. Q715 is cut off, during the ramp time, which produces a positive gate at the collector. R707 and C716, in the emitter of Q705, act as a speed-up circuit to lower the emitter impedance when the leading edge of the sawtooth appears at the collector. This permits the collector to fall rapidly.

The positive gate from Q715 is applied to preset terminal (pin 6) of U721 and U724 and through U725 to preset terminals of U722, U723, U731, and U734, the flip flop counters. The counter is locked in preset for the duration of this preset gate. U722, U723, U731, and U734 are also preset each time pin 5 of U724 goes high. This counter countdown ratio is 35:1.

U711 is a divide-by-2 counter, triggered by the negative (trailing) edge of the vertical blanking signal to allow the 35 state counter to be preset only every other field. This insures proper interlacing of the convergence pattern (see Fig. 3-11).

To shift the display one line, when the VERT POSITION control is rotated, it is necessary that the preset pulse to the 32 state counter occur in the opposite field. U712B determines the field to which the preset pulse occurs. This is accomplished as follows: the preset pulse appearing at the output of Q715 is differentiated by R711 and C712. The differential pulse is applied to pin 3 of U712B. The gate is open only if the 15,734 Hz signal to pin 5 is negative at the same instant the negative spike appears at pin 3. If the gate opens, a preset to U711 causes this flip-flop to change states. When the flip-flop changes states, one count is added and a field change occurs. CR703 and C702 ensure that the gate of U712B is open less than 50% of the time for the 15,734 Hz signal. This gives the system a hysteresis, thereby making the flip-flop favor its present state. The action of U712B can best be described as a vernier vertical position control.

To produce crosshatch, a pattern display with lines and dots centered with respect to each other; to minimize flicker, and to maintain standards; 15 horizontal rows of lines and dots must be generated (35:525). U721, U722, U723, U724, U731, U734, and U741A are the stages of the 35 state counter, used for generating timing signals necessary to ensure the above-listed conditions. The counter is triggered by the trailing edge of the line blanking signal at pin 2 of U731. Refer to Fig. 3-12 for the time-related waveforms of the counter.

U732, U733, U735B, U741B, U742, U743B, and U744 are the logic stages required to combine the timing signals from the 35 state counter to produce the proper interlace of the convergence signals. Line logic is obtained from U742 and U744, while U735B and U733 are dot logic stages. Referring to Fig. 3-11 and Fig. 3-12, it can be seen that three field lines are required to produce one dot and that two field lines are needed for one line. Only after one complete frame will the complete dots and lines be formed. Dot and line interlacing logic information is also given in Fig. 3-12 by a series of dashed lines from the input signals to the output signals. U735A, U743A, and U745 comprise the field line and dot pulse combination logic circuitry. Timing gates from the various integrated circuits of the Field Timing Generator and the line and dot pulse information from the Horizontal Timing Generator circuits are combined to produce the crosshatch drive to the output.

Output Amplifier

The Output Amplifier includes Q728, Q737, Q738, Q739, Q787, Q788, Q789, Q797, Q798, and Q799. Transistors Q787, Q788, Q789, Q797, Q798, and Q799 perform the current-switching necessary to combine the composite blanking, composite sync, and the convergence pattern information, to form the complete convergence pattern signal. This convergence pattern current then drives the filter, L768-C768 and L769-C779-C759.

The filter has a $\sin^2$ response with a risetime of 115 ns, which prevents ringing in transmission cables connected to the output connectors. The filter is terminated by R759 at the emitter of Q739.

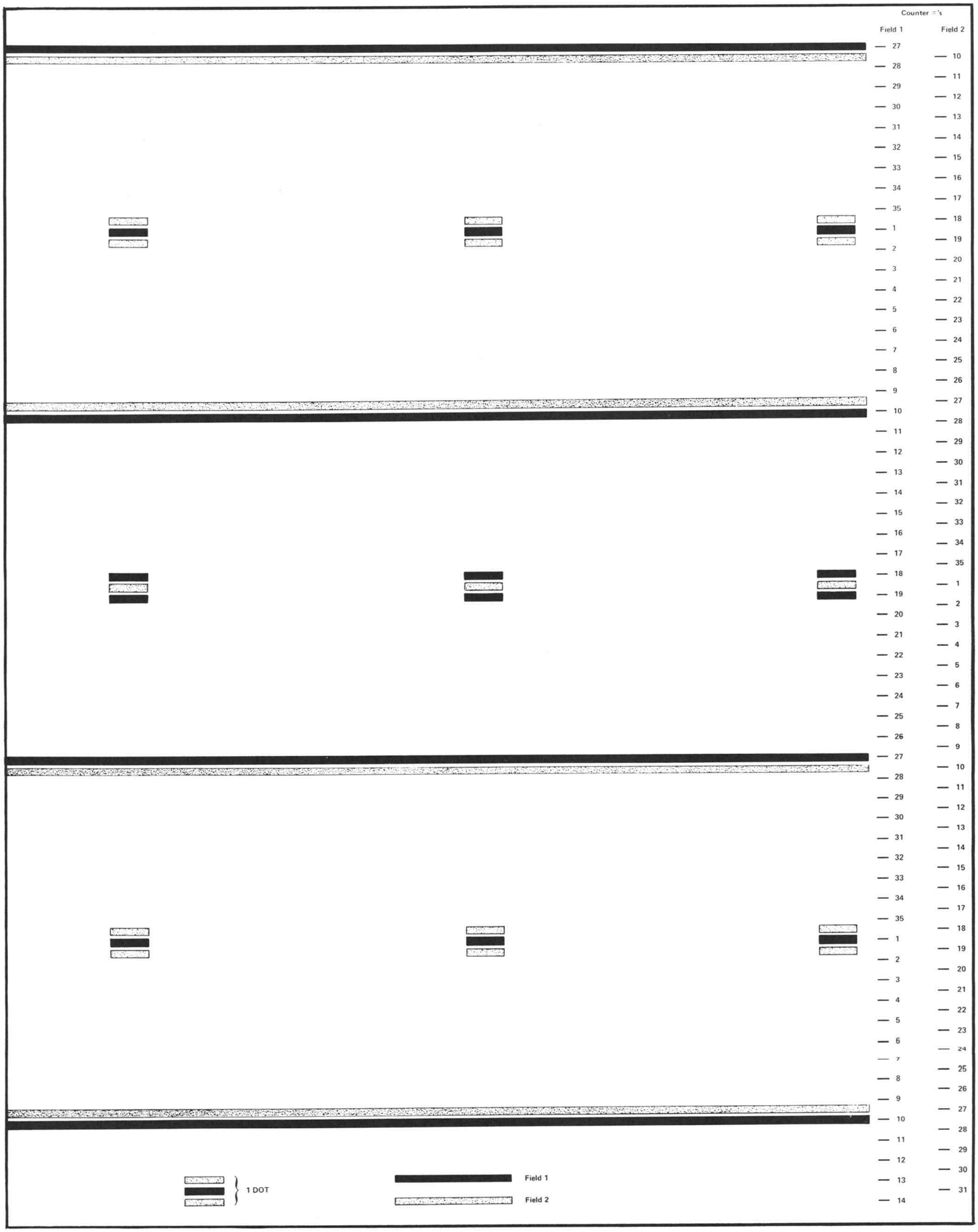


Fig. 3-11. Partial view of convergence interlacing pattern in relation to 35 state counter.

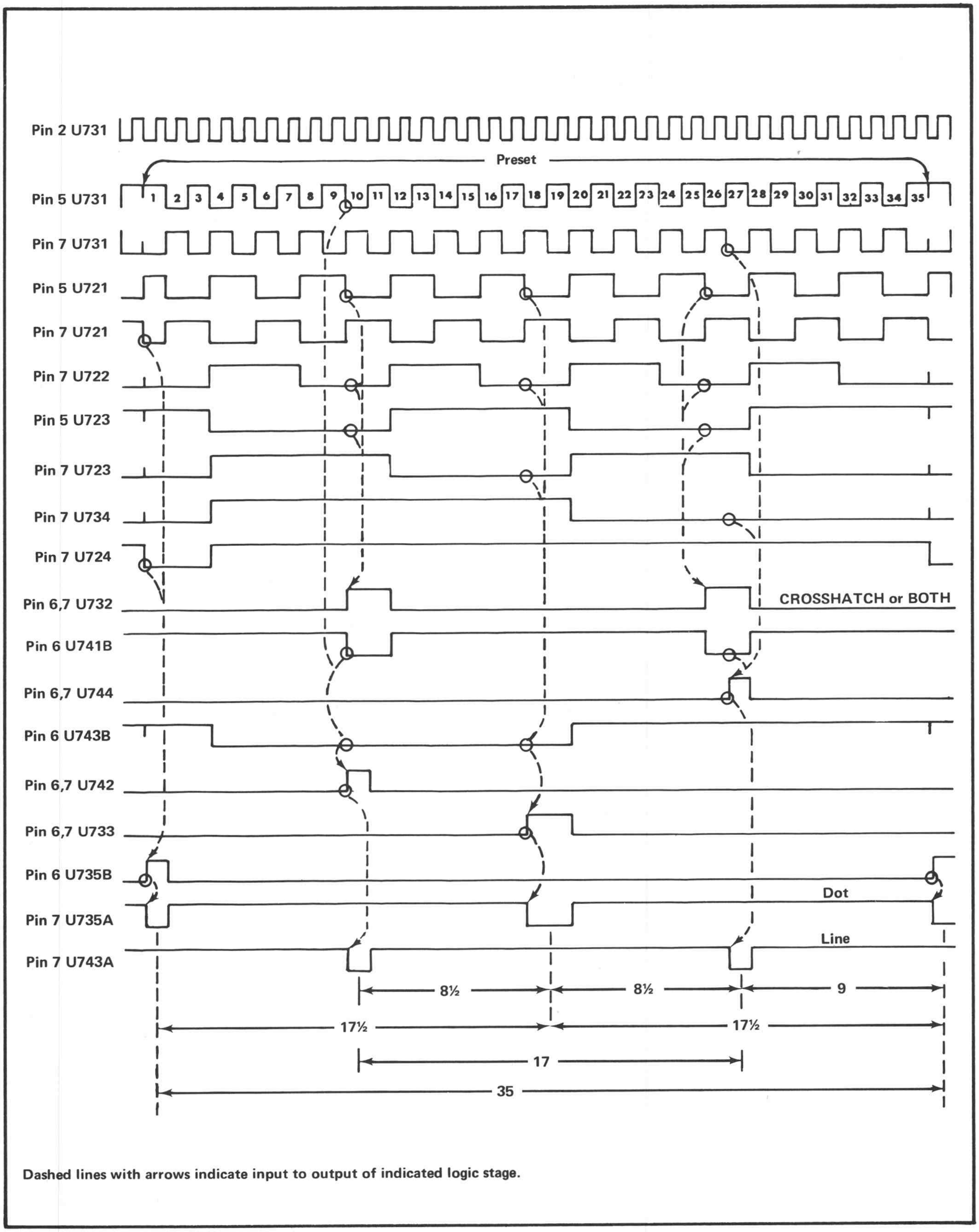


Fig. 3-12. Time-related sequential waveforms in the Field Timing Generator and Logic outputs.

The output stage is an operational amplifier (Q728, Q737, Q738, and Q739) with a very low input impedance to match the filter. R_f for the amplifier consists of R729 and R739. Adjustment of R729 sets the gain of the stage, providing a calibrated amplitude at the output. Q737 sets the emitter voltage of Q738 and provides temperature compensation. CR749 in the base of Q739 is also temperature compensator.

The amplified convergence signal is applied through R718 and R719 to the front- and rear panel CONVERGENCE PATTERN connectors.

LOW VOLTAGE POWER SUPPLY ⟨8⟩

The Low Voltage Power Supply circuit provides the following voltages for the 146: Three regulated supplies, −15 volts, +3.6 volts and +10 volts, and a +10 volt unregulated supply. Electronic regulation is used to provide stable, low ripple output voltages. All the regulated supplies are current limited to prevent instrument damage in the event that a supply is shorted to ground. The primary circuit of the transformer employs voltage and range selector plugs to permit selection of the line voltage operating range.

Power Input

Power is applied to the primary winding of transformer T1 via RFI Filter FL4, the POWER switch S4, 115 volt line fuse F2, Voltage Selector plug S3 and the Range Selector plug S2. The Voltage Selector plug S3 connects the split primaries of T1 in parallel for 115 volt range of operation, or in series for 230 volt range. A second line fuse, F3, is connected into the circuit when the Voltage Selector plug is placed in the 230 volt position to provide the correct protection for 230 volt operation. The current rating of F3 is approximately one half of F2.

Range Selector plug S2 allows the instrument to regulate properly on higher or lower than normal line voltages. Each half of the primary has taps above and below the 115 volt (230 V) point. As the Range Selector plug is moved from LO to M and then to HI, more turns are added to the primary winding. Therefore, whether the primary voltage has increased or decreased, the secondary voltage can be maintained at a nearly constant level ($E_s = E_P \times N_s/N_p$).

The RFI Filter FL4 serves to prevent external RF interference from appearing across T1 and also prevents signals generated within the 146 from being introduced onto the AC line.

−15 Volt Supply

The −15 volt supply provides the reference voltage for the +3.6 volt and +10 volt supplies (see Fig. 3-13). The reference for the −15 volt supply is 9.1 volt Zener VR870.

The output from the secondary winding (terminals X and Y) of T1 is rectified by a full-wave rectifier consisting of CR861 and CR862. The rectified voltage is filtered by C61 and applied through a −15 Volt series regulator stage Q85 to the load. Series regulator Q85 and its driver E.F. (emitter follower) Q880 are controlled by a Voltage Comparator consisting of Q875 and Q876 with associated components.

The base of Q875 in the voltage comparator stage is referenced by a 9.1-volt temperature-compensated zener diode, VR870. The voltage on the base of Q876 is determined by a divider network consisting of R885, −15 Volts control R886 and resistor R887. Variable resistor R886 adjusts the base voltage of Q876 so the output voltage of this supply is −15 volts within a tolerance of 1%. The collector potential of Q875 is applied to driver circuit Q880; this circuit controls Q85, connected as a series regulator.

Network R880 and C880 suppresses any tendency for the voltage comparator stage to oscillate. C871 filters out any noise generated by VR870.

Q860 with associated components is an overload protection circuit. This transistor is normally cut off. However, if the −15 volt supply load current is excessive, current through R861 forward biases Q860. The collector current from Q860 flows through R816 (in the +10 volt supply) and causes the base of Q830 to go in the negative direction. The emitter of Q830 follows the base, pulling the base of Q35 down and shutting down the +10 volt supply.

The negative-going voltage change at the emitter of Q830 also appears across R831 and is coupled through R875 and C875 to the base of Q880. The emitter of Q880 follows this change, pulling down the base of Q85 which shuts down the −15 volt supply.

+3.6 & +10 Volt Supply

Since both supplies are similar to the −15 volt supply, their operation is not described in detail.

OUTPUT AMPLIFIERS ⟨9⟩

The Output Amps board contains the output amplifiers for the COMP BLANKING, COMP SYNC, VERT DRIVE, HORIZ DRIVE and BURST FLAG signals available at front and rear panel connectors. These five amplifiers are nearly identical in operation, making it possible to use one which is working properly as a reference when trouble-shooting another which is defective. A description of the Comp Blanking Output Amp follows. This description may be

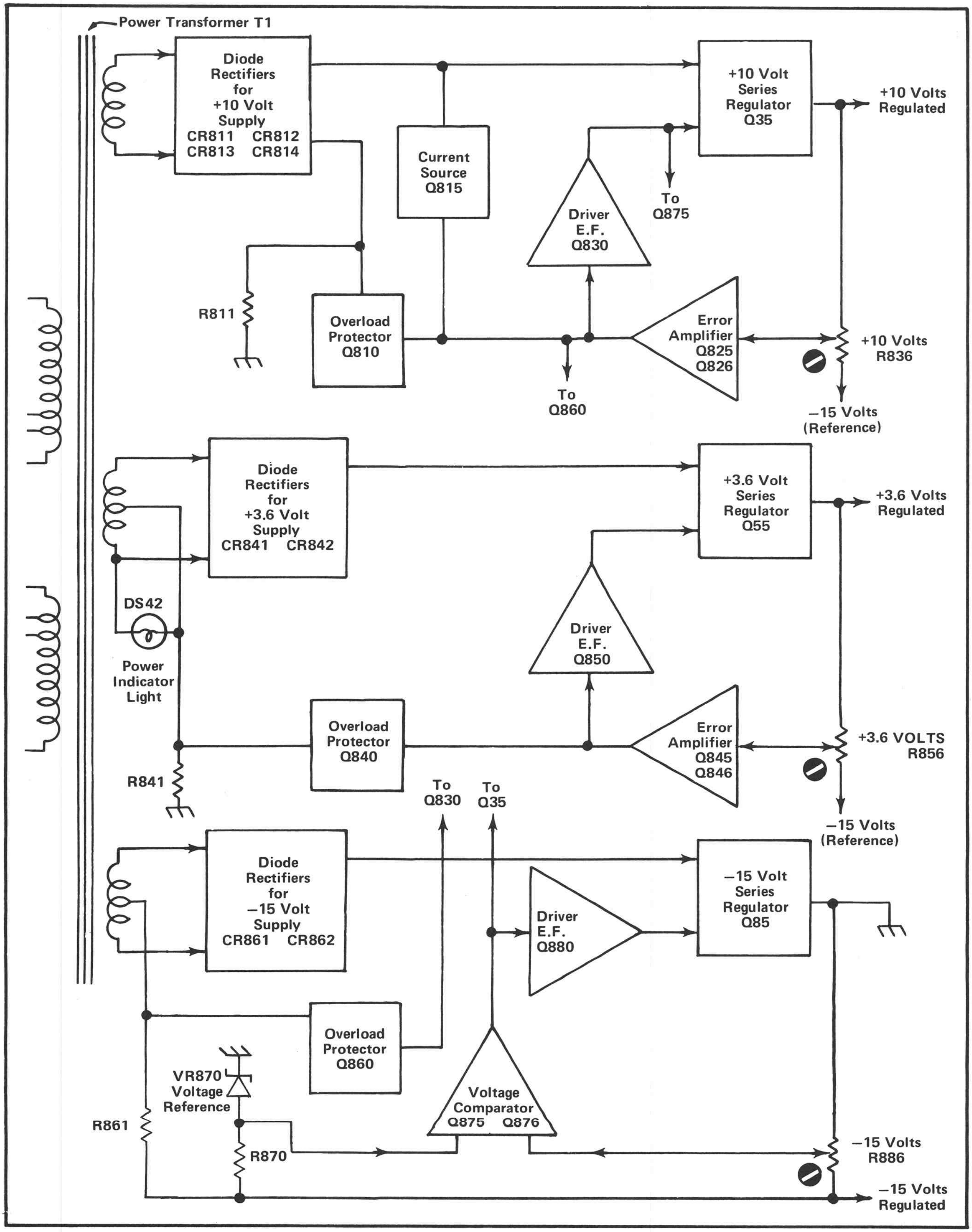


Fig. 3-13. Block diagram of the low-voltage regulated power supplies.

used to gain an understanding of the operation of the other four amplifiers.

Comp Blanking Output Amp

The Comp Blanking Output Amp includes Q980, Q982, Q990, Q992, Q994, Q996 and Q998.

The composite blanking signal, from the Comp Blanking Logic circuit is applied to pin connector AE and through R982 (a VHF oscillation suppressor) to the base of Q982. This composite blanking signal is positive in polarity with an excursion from approximately 0 V to +2 V.

Q980 and Q982 operate as a current switch. The positive signal at the base of Q982 drives Q982 into cutoff, diverting the current flowing in R981 through Q980. The relatively high output impedance of Q980 serves as a constant current source to drive the filter, L984-C984 and L985-C985-C986. The filter limits the risetime of the composite blanking signal to prevent ringing in transmission cables.

Q990, Q992, Q994, Q996 and Q998 are the active components for an operational amplifier. R990 is the feedback resistance. The input current is determined by R981. Q996 and Q998 are parallel-connected to supply the negative-going drive to the two COMP BLANKING outputs. Q994 (an NPN) provides current for reverse terminating any negative pulses which may appear at the output terminal due to unterminated coaxial cables.

R992, R993, R994, C992 and C994 automatically set the current in Q994 and Q996 at approximately 2 mA, while allowing the amplifier to deliver a positive pulse current of approximately 50 mA to the output connectors.

Q964 is common to all five amplifiers, supplying temperature-compensated base bias for Q900, Q920, Q940, Q960 and Q980.

SUBCARRIER OSCILLATOR & OUTPUT ⟨10⟩ & ⟨11⟩

The Subcarrier Oscillator & Output consists of the Subcarrier Oscillator, Oscillator Oven, Oven Temperature Indicator Lamp Drivers, Oscillator Output, Limiting Buffer Amplifier, and the Goniometer Drive and Subcarrier Output Amplifier.

Subcarrier Oscillator

Q1126, Q1127, and U1126 comprise a crystal controlled modified Colpitts oscillator. CR1122 is a voltage variable capacitance diode that shifts the oscillator frequency a slight amount when it is driven by the oscillator phase control voltage. The master oscillator free-runs at 3.579545 MHz within ±5 Hz. (See Subcarrier Logic circuit description.)

Q1127 supplies the sustaining feedback for the oscillator and serves as the output driving stage.

Oscillator Oven

Oven temperature is sensed by a bridge network consisting of R1134, R1135, R1136 and R1137. R1135 and R1136 are nickel resistive elements with a temperature coefficient of +0.55%/°C.

When the oven is cold, bridge unbalance causes Q1135B to conduct most of the current. The positive output of Q1135A, therefore, increases the forward bias of Q1131. This causes heavy conduction through the heating element R1131 which heats the oven chamber.

Oven Temperature Indicator Lamp Drivers

Normal operating temperature for the oven is indicated by a front-panel lamp which lights when the oven is at the proper temperature. Q1111 and Q1101 form this circuit, with both transistors biased off during warmup.

The oven is protected from overheating (due to a failure in the temperature control circuitry) by thermal cut-out switch S1131.

Oscillator Output

Q1105 is an emitter follower which serves as a buffer and driver. It isolates the oscillator from the output and, because it is biased near cutoff, it clips the negative portion of the input signal so the drive signal to Q1106 pulses the collector tank circuit L1147 and C1149. When CR1105 is turned on by a disable voltage from the Subcarrier Switching circuit, it shunts the oscillator signal at the emitter of Q1106 to ground and removes the internal subcarrier. L1147 tunes the tank circuit to the oscillator frequency, and is adjusted for maximum output.

Limiting Buffer Amplifier

Q1118 and Q1138 comprise the Limiting Buffer Amplifier. Its operation is similar to the Oscillator Output stage.

Goniometer Drive & Subcarrier Output Amplifier. Q1159, Q1168, and Q1179 are connected as an operational amplifier. This circuit serves as a distribution amplifier to drive the various circuits within the 146, requiring subcarrier plus the front-and rear SUBCARRIER output connectors.

SYNC STRIP & CHROMA AGC AMP ⟨12⟩

The Sync Strip & Chroma AGC Amplifier consists of Q5010 through Q5210. A Back Porch Generator is also incorporated.

Sync Strip Circuit

The Sync Strip circuit consists of Q5010 through Q5120. This circuit strips the sync from the externally applied composite video signal. Processing of the composite sync eliminates any degradation of the incoming composite sync such as white noise, 60 Hz hum, etc.

Basically, processing of composite sync is accomplished by clamping the sync tip level of the external composite video to a predetermined level, then adjusting the blanking level by controlling the overall circuit gain.

Fig. 3-14 is a block diagram of the Sync Strip circuit, and the description that follows is keyed to this and diagram 12.

The sync tip of the external sync signal (applied to the GEN LOCK connectors) is clamped at the sync level by the Sync Tip Comparator circuit, consisting of voltage comparator Q5110 and CR5110, operating as a current switch. The comparator is rate limited and uses the DC coupled sync to activate it. Once the comparator is switched, any tilt from both the field and line rate sync tips is eliminated. The rate limiting allows the feedback loop (through Q5060 and Q5050) to open at the trailing edge of the sync pulse, as well as making the loop unresponsive to impulse noises.

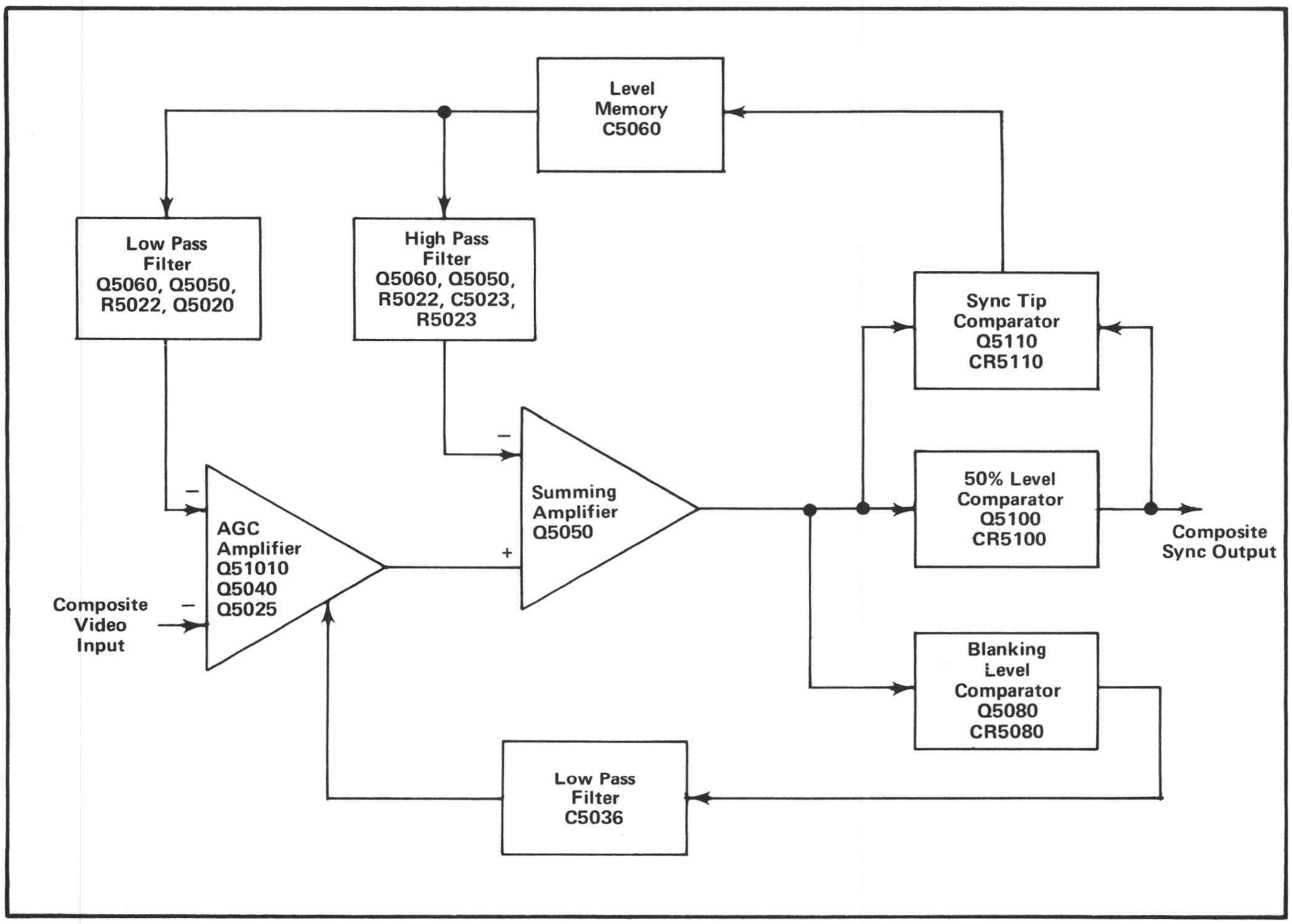


Fig. 3-14. Block diagram of Sync Strip circuitry.

It also allows the Level Memory (C5060) to average the white noise on the sync tip during the time the loop is closed, which determines the sync tip level.

The output from the Level Memory is applied to two filters. The high frequency errors (sync tip tilt) pass through the High Pass Filter, (R5023-C5023) and drives the Summing Amplifier (Q5040). The low frequency components are fed back via the low Pass Filter (Q5020) to drive the AGC Amplifier (Q5010, Q5025, and Q5040). This eliminates most 60 Hz interference.

The 50% Level Comparator, Q5100 and CR5100, processes the sync at the 50% amplitude point between the sync tip level and the blanking level, ensuring correct sync width.

The Blanking Level Comparator, Q5080 and CR5080, uses the difference in the duty factor between the sync pulse width and blanking width to determine the blanking level. This allows the entire system to function because timing information is not required to close the AGC loop. The Low Pass Filter (C5036) averages the output of the Blanking Level Comparator and this voltage controls the overall system gain through Q5025.

Back Porch Gate Generator

The Gate Generator consists of Q5130 and Q5140. It provides gate pulses to the demodulators which correspond to (1) the time of line sync and back porch, or (2) the time of back porch only.

Negative-going composite sync pulses via the sync strip circuit are applied to CR5126. CR5126 reverse biases on the leading edge of the composite sync and C5126 charges towards −15 V through R5126 in a negative direction. The charge path for C5126 is via Q5130 (normally on) and R5126. During the trailing edge, of the input composite sync, CR5126 is forward biased which couples a positive pulse through C5126 and turns Q5130 off, producing a series of negative-going pulses at the collector of Q5130. These pulses are coincident with, the trailing edge of line sync, the equalizing pulses, and vertical sync pulses.

With the BURST-CW jumper wire in the BURST position, composite sync pulses via R5128 are added to the delayed pulses out of Q5130 to drive Q5140. The duration of the output positive pulses to the demodulators corresponds to the time of the input line sync and back porch. With the BURST-CW jumper wire in the CW position, the pulse output duration, to the demodulators corresponds to the time of back porch only.

AGC Subcarrier Amplifier

The AGC Subcarrier Amplifier consists of the Chroma Trap (C5004 and L5004) and Q5150 through Q5210. The overall circuit is three operational amplifiers in series with external AGC control.

Chroma Trap. The trap consists of a series resonant LC circuit (C5004 and L5004). 3.58 MHz components of the signal, applied to the GEN LOCK input, are separated from the external sync by the trap and applied to the Chroma Buffer Amplifier.

Chroma Buffer Amplifier. Q5150 and Q5060 are connected as an operational amplifier with low input impedance. The ouput 3.58 MHz subcarrier signal current is then regulated by the AGC circuit and applied to a second operational amplifier, Q5180-Q5190.

AGC Operation. The gain control circuit active components include Q5170 and CR5174. This circuit regulates the subcarrier signal current, through CR5180 to the input of operational amplifier Q5180-Q5190, by shunting (through CR5174) a portion of the signal current (at the junction of C5162-C5174) through CR5174 to ground. The amount of current shunted through CR5174 depends on the current demand of Q5170. If, for example, the subcarrier signal current becomes excessive, an increased negative-going corrective signal from the AGC comparator (diagram 14) is applied to the base of Q5170. This increases the current through Q5170, which increases the current through CR5174. This decreases the impedance across the diode and shunts more of the signal current away from operational amplifier, Q5180-Q5190, thereby decreasing the gain of the amplifier stage.

Q5180 and Q5190 are connected as a low input impedance operational amplifier with the feedback resistance (R5184) shunted by CR5184-CR5186 and C5184. This provides signal limiting to ensure that the subcarrier (due to peak signals) does not leak through the demodulator during non-demodulation time.

Output Amplifier. The output amplifier (Q5200-Q5210), an operational amplifier, insures adequate drive current for the demodulators. L5190 is adjusted to compensate for subcarrier phase shift errors through the amplifiers.

QUAD DEMODULATORS 13

The Quad Demodulators, consisting of the active components Q5220 through Q5410, produce output signals which correspond to the amplitude and phase of burst (if any) from the externally applied composite video signal to control the internal master oscillator.

Quad Phase and Limiting Drivers

Q5220, Q5230, Q5240, and Q5250 are connected as differential comparators. Q5220 and Q5250 are turned on and off, at the subcarrier rate, only during line sync and back porch time (or back porch only) to provide switching current to the demodulators. Q5230 and Q5240 are driven by the subcarrier signal, with Q5230 operating 90° later than Q5240. Subcarrier delay is provided by L5235, C5230, and C5240. R5235 terminates the line. Quadrature shift allows burst demodulation in any quadrant (demodulation may take place between 0 and 360 degrees). Q5220 and Q5250 are driven simultaneously by the Back Porch Generator. (See Sync Strip and Chroma AGC Amp description.)

Quad Demodulators

The demodulators, Q5260 and Q5290, are forward biased by Q5220 and Q5250, during non-demodulation time. External chrominance signal from the Chroma AGC Amp is therefore shunted to ground through Q5260 and Q5290. During demodulation time (burst time of the external chrominance signal) Q5260 and Q5290 are switched by the demodulator enable signal at the subcarrier rate. The demodulated chrominance signal is then applied to the low pass filters L5264, C5264, L5294, and C5294. The output of the filter therefore is a DC level that represents the phase and amplitude of the external burst signal plus the internal subcarrier signal. Under normal operating conditions (in Gen Lock Mode) the output of Q5260 is 0 volts. The output of Q5290 is a negative DC voltage level during burst time.

The output of each demodulator filter drives the AC Pulse Amplifiers.

AC Pulse Amplifiers

Q5270, Q5280, Q5300, and Q5310 amplify the demodulated chrominance signal level obtained from the filters and drive memory capacitors C5282 and C5312.

Reference Clamps

Q5320 and Q5350 hold the inputs to the Quad Phase Burst Rectifiers and Buffer Amplifiers at 0 volts during non-demodulation time. This allows the memory capacitors to charge to a DC level dependent upon the phase and amplitude of the demodulated signal.

During back porch time, a signal applied from the Back Porch Gate Generator turns Q5320 and Q5350 off. This permits the charge on the memory capacitors to drive the Quad Phase Burst Rectifiers and Buffer Amplifiers.

Buffer Amplifiers

Emitter followers Q5330 and Q5360 provide sufficient current to drive the DC Error Amplifier, Quad Lock Detector, and Rectifier circuits (see diagram 14). This circuit also isolates the input to the Quad Phase Burst Rectifiers.

Quad Phase Burst Rectifiers

Q5340 and Q5370 are the active components of this stage and are connected as phase inverters. This allows detection of the demodulated signal in any quadrant.

During back porch time the charge, if any, on the memory capacitors drives Q5340 or Q5370 to produce a positive or negative (depending on phase) output. The most negative pulse is then coupled through one of the diodes CR5347, CR5348, CR5377, or CR5388 to drive the Burst Tip Detector Q5400.

Burst Tip Detector

Q5400, an inverting amplifier, drives the DC Restorer Clamps (Q5390, Q5380) during burst tip time. C5404 holds the level of the last negative pulse applied from the Quad Phase Burst Rectifier stage. This sets the bias of Q5400 near turn on, reducing the time to turn on the DC restore clamps Q5390 and Q5380.

DC Restore Clamps

Q5380 and Q5390 restore the DC level of the demodulated chrominance signal (Phase Control and Quad Signals) from the Buffer Amplifiers (Q5330, Q5360) during burst tip time. When the Burst Tip Detector Q5400 turns on, both Q5380 and Q5390 are turned on. This clamps the output of the Quad Demodulator stage (TP5380 and TP5390 at about 0 volts.

Burst Lock Disable

Q5410 is the active component of this stage and is used to turn on the DC Restore Clamps except during Gen Lock.

With the 146 operated in the INT, EXT STD, or COLOR GEN LOCK (with loss of composite sync) modes, Q5410 is turned on by a signal from the Sync Present Detector (see diagram 15). This turns the DC Restore Clamp transistors on, clamping the output of the Quad Demodulator stage (TP5380 and TP5390).

CHROMA AGC COMPARATOR & SUBCARRIER LOGIC 14

The Chroma AGC Comparator and Subcarrier Logic consists of Q5420 through Q5610. A block diagram is

shown in Fig. 3-15. The description that follows is keyed to this block and diagram 14.

500 Hz Filter

R5420, C5420 and R5440, C5440 filter signal pulses from the Quad Demodulators to provide a signal that corresponds to the amplitude and phase of the external burst.

Quad Phase Rectifier

To provide lockup, independent of external burst phase errors VS internal subcarrier phase at the moment of Gen Lock attempt, Q5420, Q5430 and Q5440, Q5450 are connected as paraphase amplifiers.

The output of each amplifier is applied to a peak detector.

Peak Detector

The peak detector circuit consists of CR5420, CR5430, and CR5440, CR5450. The most negative DC level from the Quad Phase Rectifier circuit is detected and applied to the DC Buffer Amplifier.

DC Buffer Amplifier

Q5460, an emitter follower, acts as a buffer and provides the necessary drive for the AGC Comparator and Burst Present Detector circuits.

The output of the buffer is filtered by R5462 and C5470 to insure an average DC level control voltage to the above circuits. The filter has an approximate bandpass of 5 Hz, which allows noise that may appear at this point to be common mode to both sides of the comparator Q5470 and Q5480.

AGC Comparator

Q5470 and Q5480 are connected as a differential comparator with the base of Q5480 referenced to a fixed DC level.

When operating the 146 in INT mode, the AGC comparator is biased by the output level of Q5460 so Q5480 is switched off. No AGC current is available to the AGC amplifier (see diagram 12). With Gen Lock operation the output from the peak detector, amplified by buffer amplifier Q5460, drives the AGC comparator so an AGC current corresponding to the amplitude of the externally applied burst signal, is developed through Q5480. This current is fed back to the Chroma Amplifier and increases or decreases the overall chroma gain. Under normal Gen Lock operation, burst amplitudes of 10 to 40 IRE units switch the comparator and produce an AGC output current.

Burst Present Detector

Q5490 and Q5500 are connected as a Schmitt Trigger. In INT mode, Q5490 is off, Q5500 is on.

When operating the 146 in the COLOR GEN LOCK mode, and if external burst is present, the output DC level from the buffer (Q5460) steps down and triggers the Schmitt multivibrator. The differential output of the Schmitt circuit drives the subcarrier reference switch.

Subcarrier Reference Switch

Q5510 and Q5520 form this circuit. Each is controlled by the Burst Present Detector.

When operating the 146 in the INT mode, both transistors are saturated. This provides a resistive divider consisting of R5513, R5515, and R5517 connected between −15 volts and ground (through both transistors). Control of the 146 internal oscillator (diagram 10 & 11) frequency depends on the setting of R5515. When operating in the COLOR GEN LOCK mode, Q5510 and Q5520 are reverse biased by the output of Burst Present Detector causing the Subcarrier Reference Switch circuit to "float". Control of the internal master oscillator now depends on the Quad Demodulators output signals that are applied to the Error Amplifier (Q5540, Q5530).

Error Amplifier & Band Switch

This circuit controls the 146 master oscillator frequency during Gen Lock mode of operation. Q5530 and Q5540 are connected as an integrating operational amplifier with C5542 as the feedback capacitor. Ri for this amplifier consists of R5555 or R5555 shunted by R5552 and the transistor switch Q5550.

The rate of integration of the operational amplifier is changed by switching, the Band Switch, Q5550 on or off. The input resistance (Ri) is low when Q5550 is switched on. This increases the rate and amount the output voltage of the amplifier shifts the internal master oscillator. With Q5550 turned off, the rate is relatively slow (Ri high) and the bandwidth shift of the oscillator is narrow, improving the noise immunity of the amplifier. Control of Q5550 is obtained from the Quad Lock Detector circuit.

Quad Lock Detector

The Quad Lock Detector circuit consists of a lock delay circuit (Q5610) and a Schmitt multivibrator circuit

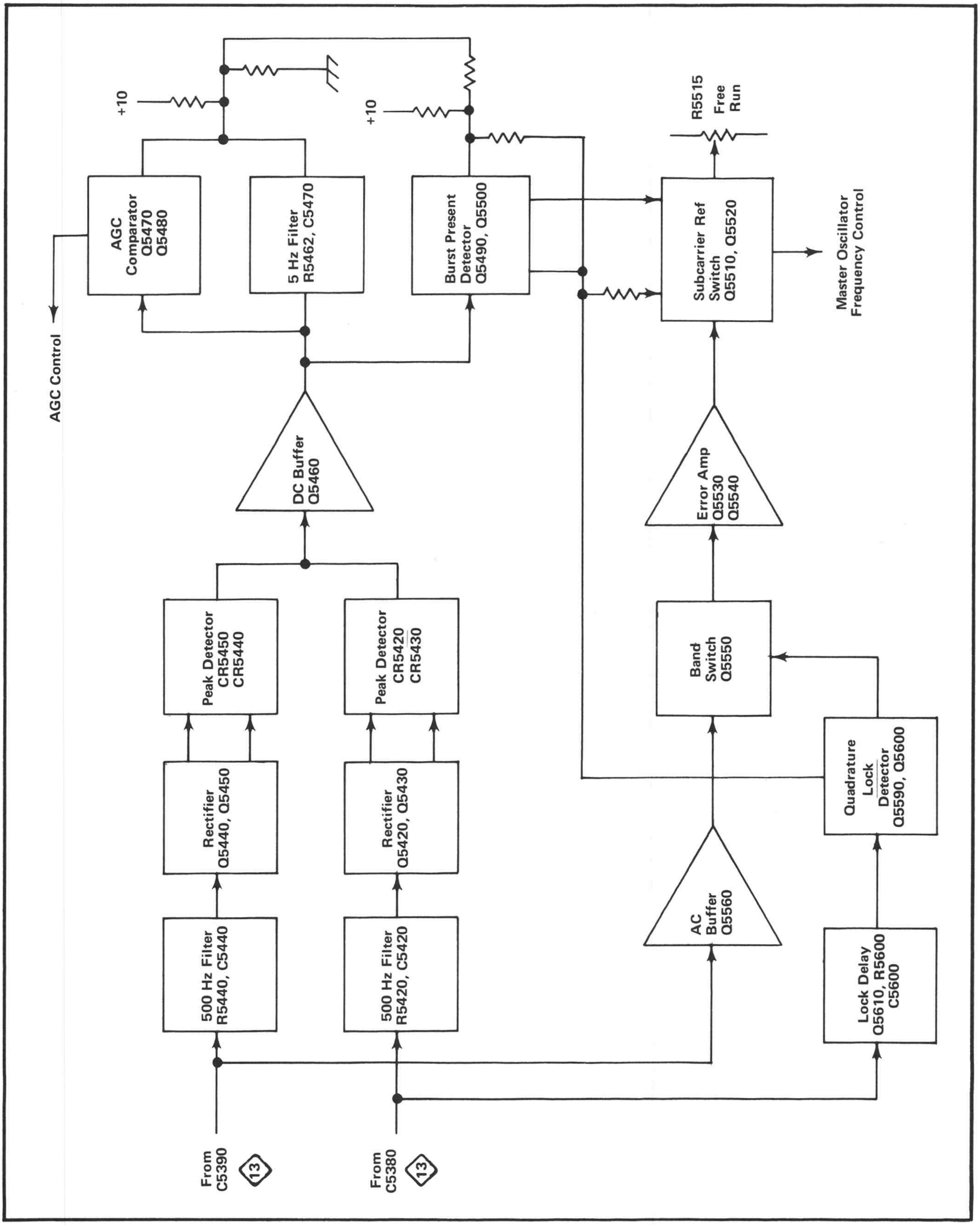


Fig. 3-15. Block diagram of Chroma AGC Comparator & Subcarrier Logic.

(Q5590-Q5600). The output of the multivibrator controls the Band Switch.

During initial Gen Lock, Q5610 is forward biased by a negative pulse applied via CR5506 from the Burst Present Detector circuit. This discharges C5600, which turns Q5600 on. The output of the detector (collector circuit of Q5590) is therefore a negative gate which switches Q5550 on. When lock occurs, Q5610 is turned off, by the quadrature signal from the Demodulator circuit, allowing C5600 to charge towards +10 volts. This delays triggering the Schmitt multivibrator to turn Q5550 off, which ensures lock has occured.

Q5570 and Q5580 are part of the AUTO INT SUBCARRIER light drive circuit as described with diagram 16.

FIELD SYNC LOGIC ⟨15⟩

The Field Sync Logic circuit, consisting of Q5620 through Q5740 and U5650 through U5700, synchronizes the Field Counter of the 146 generator to the externally applied composite sync signal, drives the AUTO INT SYNC indicator, and contains the Video Enable Logic circuit.

Composite sync from the external composite video signal is processed in the Sync Strip circuit and applied to the input (base of Q5630, Q5620) of this circuit.

Non Sync Inhibit

The positive charge, developed on C5626 by the incoming composite sync signal, is enough to turn Q5620 on. This allows composite sync to get through the Vertical Sync Integrator and Peak Detector to the Serration Counters (U5650-U5670) and preset the internal Field Counters (see diagram 3). If composite sync is lost, Q5620 turns on to hold Q5630 off, thus inhibiting the Field Preset output pulse.

Vertical Sync Integrator and Peak Detector

The Vertical Sync Integrator, consisting of C5630 and R5630, has a time constant such that only the vertical serration pulses of the composite sync signal will charge C5630 sufficiently to turn Q5640 on. This occurs only during the peak of each integrated waveform. The positive output pulse of the Peak Detector is then applied through emitter follower Q5650 (Buffer Amplifier) to the Vertical Serration Counter and Preset Circuits.

Counter Preset

Q5660 and Q5670 are the active components for the preset circuit. Prior to the field blanking interval, Q5670 is biased on. This presets the Serration Counter U5650, U5660, and U5670. The leading edge of the first integrated pulse from Q5650 switches Q5660 on, which turns Q5670 off. This releases the counters. If the delay between integrated pulses exceeds 35 µs, the charge on C5662 will turn Q5670 on and preset the counters.

Serration Counter

The trailing edge of each integrated pulse toggles U5650. On the sixth integrated pulse, all inputs to the four input AND gate (U5680) are low, which gates the output high and sets the internal field counter. This also presets the Serration Counters, via Q5690 and Q5680. They are now ready for the next field.

Field Sync Present Gate

If a positive pulse is not available from the Serration Counter, C5710 charges sufficiently to turn on, which turns Q5720 on. The positive output from Q5720 disables the Quad Demodulators (see diagram 13) and switches the Line Counter back to internal. If a positive field preset pulse is obtained from U5680, Q5700 turns on and discharges C5710. Q5710 and Q5720 are now switched off.

Lamp Drive and Video Enable Logic

This circuit consists of two negative input AND gates U5700A, U5700B and transistors Q5730 and Q5740.

During normal Gen Lock operation, pin 2 of U5700A is high, pin 7 is low preventing Q5730 and Q5740 from (1) turning on the AUTO INT SYNC light and (2) gating pin 6 of U5700B high to allow the Video Enable circuit (see diagram 3) to operate.

If Q5720 (see Field Sync Present Gate) is on, a low will be applied to U5700A; the (1) AUTO INT SYNC Lamp will light and (2) the video portion of the composite video signal will be removed.

SUBCARRIER SWITCHING ⟨16⟩

The Subcarrier Switching circuit consists of Q5750 through Q5850, AUTO INT SUBCARRIER light (DS58), and the SYNCHRONIZATION REF switch (S56).

Internal-External Switch

The electronic switch consists of differential comparator Q5810 and Q5820, and disconnect diodes CR5812 and CR5822. This circuit selects either the internal or external subcarrier and applies the selected signal to the switch buffer amplifier (Q5840, Q5850). With S56 set to INT or

COLOR GEN LOCK position, the base of Q5820 is clamped at approximately −0.5 volt by CR5820. The collector voltage of Q5820 then holds CR5822 in a reverse biased condition which prevents external subcarrier, if any, from being applied to the switch buffer amplifier (Q5840, Q5850). With Q5820 on, Q5810 is off and its collector voltage forward biases CR5812. With CR5812 forward biased, the internally generated subcarrier is applied to the switch buffer amplifier.

With S56 set to EXT STD, assuming external subcarrier is present, CR5812 is reverse biased and the external subcarrier is allowed to pass via CR5822 to the switch buffer amplifier. If external subcarrier is lost while in the EXT STD mode, the electronic switch functions as if in the INT mode.

Input Amplifier

The amplifier, Q5750 and Q5760, is connected as an operational amplifier. To eliminate bypass capacitors, Q5750 is connected as a grounded base stage and Q5760 is connected as a grounded emitter. The output of the operational amplifier drives the Subcarrier Detector circuit (Q5780, Q5770) and the switch buffer amplifier (Q5840, Q5850).

Subcarrier Detector

This stage, consisting of Q5770 and Q5780, insures that external subcarrier is present before allowing the electronic switch to forward bias CR5822. L5774, with shunt distributed capacitance, is resonant at 3.58 MHz to couple the signal to the base of Q5780 and also set the bias of Q5780 below cutoff. This allows only the most positive excursions of the external subcarrier signal to drive Q5780 into conduction. The collector output is filtered by C5782; therefore, the output of Q5780 is a DC level that depends on the presence of external subcarrier. This DC level is then used as a control voltage for the Lamp and Switching Logic circuit.

Lamp and Switching Logic

This stage consists of Q5790, Q5800, Q5830, AUTO INT SUBCARRIER Light, and the REF switch (S56). With S56 in the INT or COLOR GEN LOCK modes, the emitter return of Q5790 and the base return of Q5830 are open. This insures that, even with external subcarrier applied to the Input Amplifier, the internal subcarrier generator is supplying the subcarrier. With the REF switch set to the EXT STD position, Q5790 and Q5830 have emitter and base returns respectively via R5790 and S56 to ground. If the DC control voltage is low, which indicates external subcarrier, Q5790 will be turned off, turning Q5830 on. The positive output of Q5830 turns off Q5820, and CR5822 is forward biased. This allows the external subcarrier to be applied to the Switch Buffer Amplifier. The positive output of Q5830 is also applied as a disabling signal to the internal subcarrier oscillator amplifier (see diagram 10 & 11). This insures no internal subcarrier.

If subcarrier (external) is lost with S56 set to EXT STD position, a high will be applied to turn on Q5790. This turns off Q5830 and turns on Q5800. When Q5800 is turned on, the AUTO INT SUBCARRIER lamp lights. Q5800 is also controlled by an indicator disable pulse obtained from Q5570 and Q5580 (see Quad Lock Detector) to turn on the light.

With Q5800 on, the voltage to pin R is positive, which disables the Chrominance Enable circuit (see Operation Options, Section 2 of this manual).

Switch Buffer Amplifier

Q5840 and Q5850 operate identical to the Input Amplifier previously described with the exception of the amplifier gain. The subcarrier output signal then drives the Subcarrier Output Amplifier (see diagram 10 & 11).

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains information for use in preventive maintenance, troubleshooting and corrective maintenance of the 146.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection and lubrication. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 146 is subjected determines the frequency of maintenance.

Cleaning

General. The 146 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket that prevents efficient heat dissipation. It also provides an electrical conduction path.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Exterior. Loose dirt accumulated on the outside of the 146 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a solution of water and mild detergent. Abrasive cleaners should not be used.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

Lubrication

The reliability of switches and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant (e.g., Tektronix Part No. 006-0172-00) for switch contacts. This lubricant does not affect the electrical characteristics of the switch. To lubricate the switch detent, use a heavier lubricant (e.g., Tektronix Part No. 006-0219-00). Do not over-lubricate.

Visual Inspection

The 146 should be inspected occasionally for such defects as broken connections, loose or disconnected pin connectors, improperly seated solid-state devices, damaged circuit boards and heat-damaged components.

The corrective procedure for most defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

Transistor and Integrated Circuit Checks

Periodic checks of the transistors and integrated circuits (ICs) used in the 146 are not recommended. The best indication of performance is the actual operation of the component in the circuit. Performance of the circuit is thoroughly checked during performance check or recalibration; and any substandard transistors or integrated circuits will usually be detected at that time.

Performance Checks and/Recalibration

To insure correct and accurate instrument operation, the instrument performance and calibration should be checked each 1000 hours of operation or at least every 6 months. Performance Check and Calibration procedures are given in Sections 5 and 6.

The calibration procedure can be helpful in isolating major troubles in the instrument. In some cases, minor

troubles not apparent during normal operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in this instrument are described here.

Obtaining Replacement Parts

All electrical and mechanical replacement parts for the 146 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the Parts List for value, tolerance and rating.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies.

Multiple Terminal Connector Holders. Most inter-circuit connections, between the circuit boards or between the boards and chassis mounted components, are made through pin connectors. The terminals in the connector holder are identified with numbers. Connector orientation to the circuit board is keyed with triangles, one on the holder and one on the circuit board. See Fig. 4-1.

Circuit Boards. If the circuit board is damaged beyond repair, replacement can be made of the entire assembly including all soldered-on components, or of the board alone. Part numbers are given in the Mechanical Parts List for either the completely wired or the unwired board. The following procedure outlines the removal and replacement of the boards.

Removal:

1. Remove all interconnecting wires from the circuit boards.

2. Remove board hold-down screws and/or unsnap one edge of the board from the plastic mounting clips.

3. Remove the circuit board.

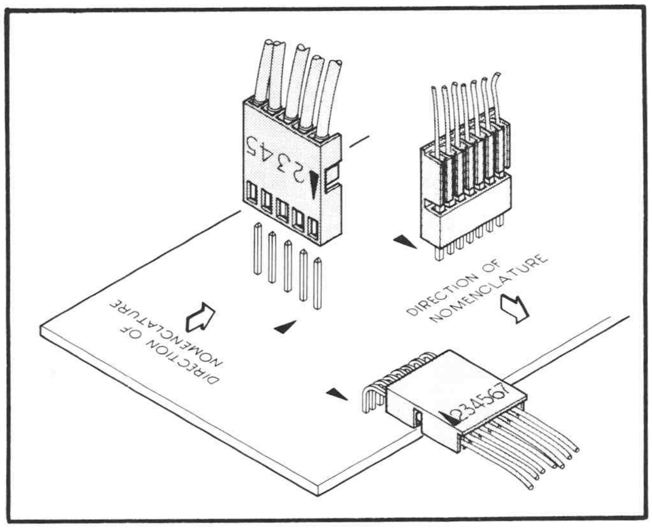


Fig. 4-1. Multipin circuit board connectors.

Replacement:

1. Replace the hold-down screws and/or insert one edge of the circuit board so that the board notches fit into the plastic mounting clips.

2. Snap the circuit board into place.

3. Reconnect all interconnecting wires to the circuit board.

Transistor and Integrated Circuit Replacement. Transistors and integrated circuits, (ICs) should not be replaced unless they are actually defective. Replacement or exchange of components may affect the calibration of the instrument. If a transistor or integrated circuit is removed during routine maintenance, return it to its original socket.

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced. Use Fig. 4-2 as a reference for insertion.

The chassis-mounted power supply transistors and their mounting bolts are insulated from the chassis. In addition, silicone grease is used to increase heat transfer capabilities. Re-install the insulators and replace the silicone grease when replacing these transistors. The grease should be applied to both sides of the mica insulators, and should be applied to the bottom side of the transistor where it comes in contact with the insulator.

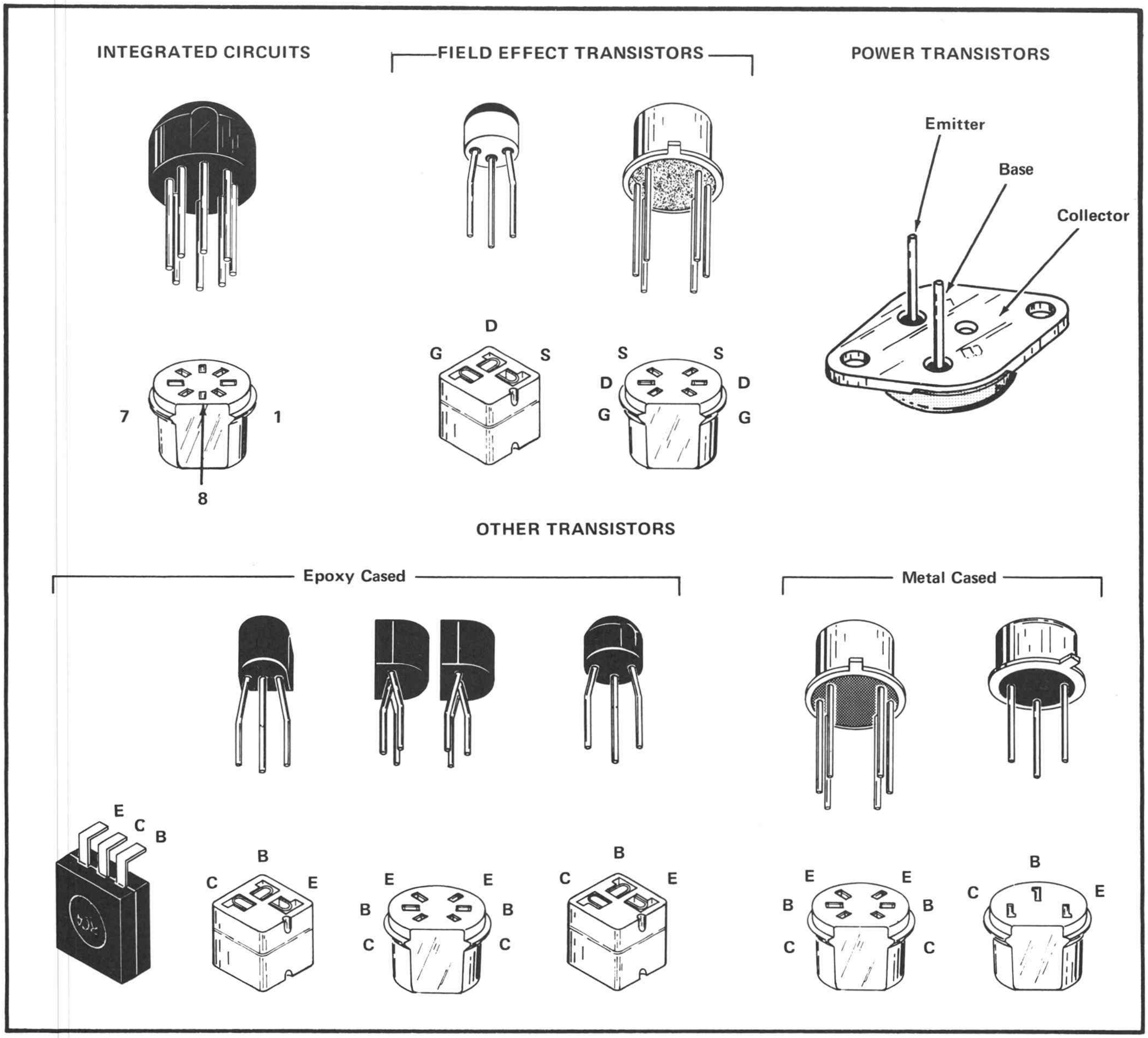


Fig. 4-2. Electrode configuration for socket mounted Integrated Circuits and Transistors. (Also, chassis mounted power transistor.)

WARNING

Voltages are present on the exterior surface of the chassis-mounted power supply transistors if the power is applied to the instrument and the POWER switch is on.

After any component is replaced, check the operation and calibration of the associated circuits.

Indicator Lamp Replacement. The lamps (except POWER ON indicator) can be removed from the front panel. To remove any lamp, unscrew the lens; use fingernails to grip the lamp, and pull outward. To replace the lamp, insert it, and rotate while applying light pressure. After the pins align with the socket, push the lamp fully into place. Replace the lens.

To remove the POWER ON indicator lamp, remove the top cover from the instrument, then reach behind the front panel and unplug the lamp from its holder. To replace the lamp, reverse the procedure.

Fuse Replacement. Both line fuses are contained in plastic holders in the cover for the Line Voltage Selector Assembly at the rear of the instrument. Use only the

correct value replacement fuse. Only the upper fuse within the assembly (3/4 A) is used for 115-volt operation. However, for 230-volt operation both the upper and lower fuse (1/2 A) must be installed.

Switches. If a switch is defective, replace the entire assembly. Replacement switches can be ordered by referring to the Parts List for the applicable part numbers.

When replacing a switch, tag the leads and switch terminals with corresponding identification tags as the leads are disconnected.

Power Transformer Replacement. If the power transformer becomes defective, contact your local Tektronix Field Office or representative for replacement. Replace only with a direct replacement Tektronix transformer.

When removing the transformer, tag the leads with the corresponding terminal numbers to aid in connecting the new transformer. After the transformer is replaced, check the performance of the complete instrument using the Performance Check procedure.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the 146. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Circuit diagrams are provided on foldout pages in Section 9. The circuit number and electrical value of components in this instrument are shown on the diagram. Each main circuit is assigned a diagram number. Important voltages and waveforms are also shown on the diagrams. The portions of the circuit mounted on circuit boards are enclosed with a blue line.

Switch Wafer Identification. The VITS Line selector switch shown on the Field Timing diagram is coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from the front, or mounting end of the switch, toward the rear. The letters 'F' and 'R' indicate whether the front or rear of the wafer performs the particular switching function. For example, a wafer designated 3R on the diagram indicates that the rear of the third wafer is used for this particular switching function.

Circuit Boards. Fig. 4-3 shows the location of each circuit board within the instrument. Each circuit board is shown (full view) opposite the appropriate diagram in Section 9. Each electrical component on the board is identified by its circuit number, and all wire color codes are shown. These pictures, used with the diagrams, aid in locating the components on the circuit board.

Wire Color Code. All insulated wires in the 146 are color coded to facilitate circuit tracing. Table 4-1 summarizes the coding system used in the 146 for chassis wiring.

TABLE 4-1

Color Code	Significance
Black	Chassis ground
White on Black	Floating ground
Yellow on Green	Safety ground
Brown[1]	Filament and heaters
Gray[1]	AC line
White[1]	Signal
Red[2]	B+
Violet[2]	B–

[1] Color stripes are used on these wires as an aid to circuit tracing.

[2] Color stripe on wire indicates position of supply with respect to 0 volts (e.g., a black stripe on a red wire would be the first voltage in the positive direction). If a second stripe is used (white only), this indicates a non-regulated supply.

Table 4-2 is provided to list the wire color code for the regulated non-decoupled DC power supply voltages used in the 146.

TABLE 4-2

146 Power Supply Wire Color Code

Supply	Color Code
–15 V	Black on Violet
+3.6 V	Black on Red
+10 V	Brown on Red

Resistor Color Code. In addition to the brown composition resistors, metal film resistors (identifiable by their gray or light blue color) are used in the 146. The resistance

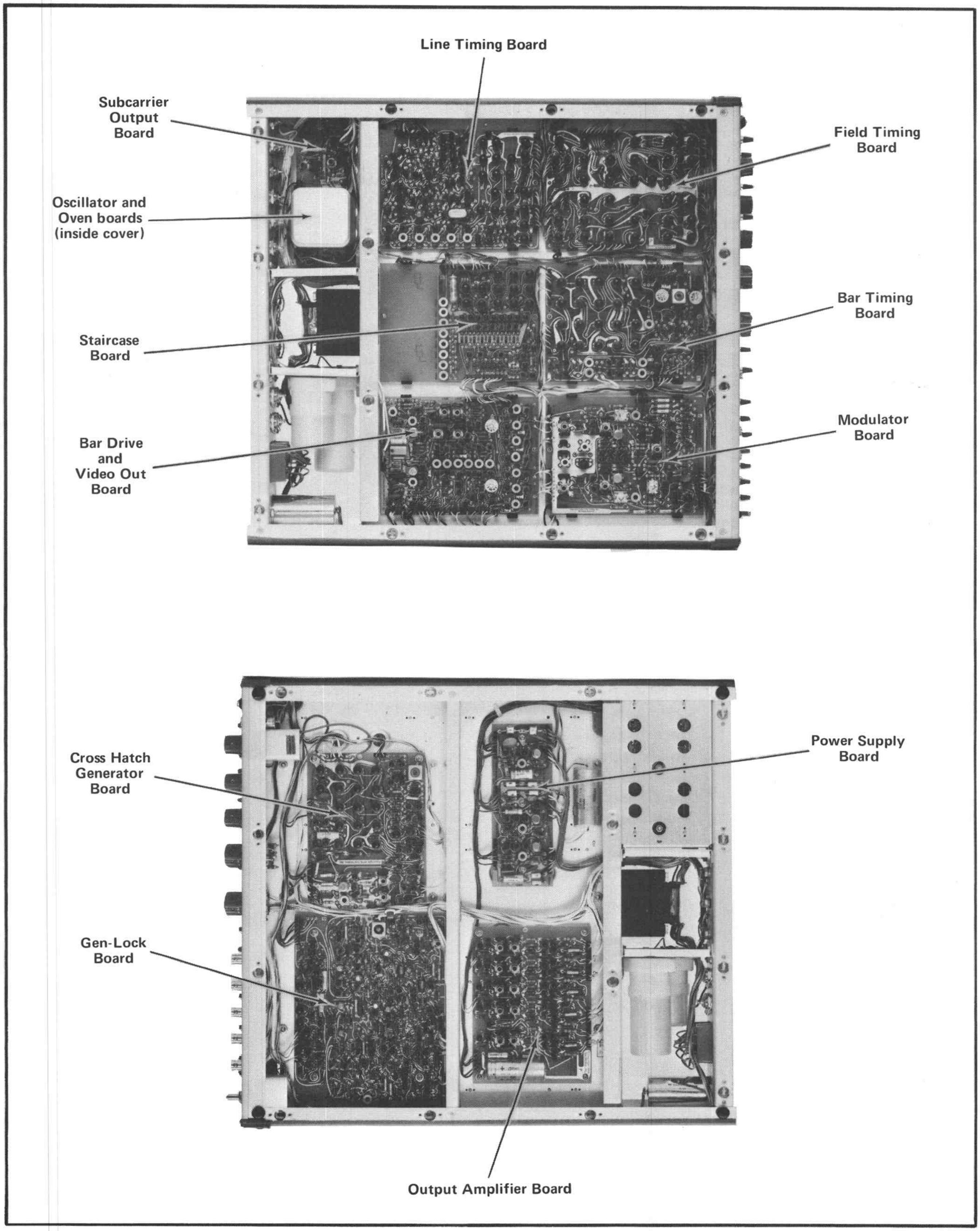


Fig. 4-3. Location of circuit boards in the 146.

value of composition and metal film resistors is color-coded on the components with the standard EIA color code.

Capacitor Markings. The capacitance value of a common disc capacitor or small electrolytic is marked in microfarads on the side of the component body. The white ceramic capacitors used in the 146 are color-coded in picofarads using a modified EIA code.

Diode Color Code. The cathode end of each glass-enclosed diode is indicated by a stripe, a series of stripes, or a dot. For metal-enclosed diodes, the anode and cathode are marked on the case.

Transistor and IC Lead Configuration. Fig. 4-2 shows the lead configuration for socket mounted transistors, FETs and ICs used in the 146.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple possibilities before proceeding with extensive troubleshooting.

1. Check Control Settings. Incorrect control settings can indicate trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions.

2. Check Operation of Associated Equipment. Many times malfunction of equipment can be traced to associated equipment.

3. Visual Check. Visually inspect the portion of the instrument in which the trouble is located. Look for unsoldered connections, loose pin connectors, broken wires, damaged circuit boards, damaged components, etc.

4. Check Circuit or Instrument Calibration. The apparent trouble may only be a result of misadjustment and may be corrected by calibration. Complete calibration instructions are given in the Calibration section.

5. Isolate Trouble to a Circuit. To isolate trouble to a circuit, note the trouble symptoms. The symptoms often identify the circuit in which the trouble is located. For example, if one luminance step in the composite video staircase signal is absent, this indicates that the Staircase Luminance Amplifier circuit is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. A defective component elsewhere in the circuit can also appear as a power-supply trouble, and affect the operation of other circuits.

The Block Diagram Circuit Description section can be used as a guide for isolating a trouble. This description explains how the various signal components are combined to form the composite video signal. By using the front-panel controls and checking the signals at the BNC connectors, it is possible to determine circuits that are functioning properly and those that are not.

When a trouble is isolated to the smallest possible area, proceed with steps 6 through 8 in this troubleshooting procedure to locate the defective component(s).

6. Check Circuit Board Interconnections. After the trouble has been isolated to a particular area or circuit, check the pin connectors on the circuit board for correct connection.

The pin connectors used in this instrument also provide a convenient means of circuit isolation. For example, a short in a power supply can be isolated to the power supply itself by disconnecting the power distribution pin connectors for the voltage at the Power supply board when making resistance to ground checks.

7. Check Voltage and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the back side of Section 9 (Diagrams) title page.

CAUTION

Due to the component density on the circuit boards, care should be taken with meter leads and probe tips. Accidental shorts can cause abnormal voltages or transients which may destroy many components.

WARNING

"Ground lugs" are not always at ground potential. Check the diagrams before using such connections as a ground for the voltmeter test prod or oscilloscope probe. Some transistors cases may be elevated.

8. **Check Individual Components.** The following procedures describe methods of checking components in the 146. Components which are soldered in place should be checked without removal, by isolating the component if circuit conditions allow. If component isolation is questionable, unsolder one end to check.

a. Transistors (excluding FETs). The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a new transistor or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 576). Static-type testers are not recommended since they do not check operation under simulated operating conditions.

b. Diodes. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High current may damage the diodes.

9. **Repair and Readjust the Circuit.** If any defective parts are located, follow the replacement procedure given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

NOTES

SECTION 5
PERFORMANCE CHECK

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This procedure checks the instrument to the performance requirements listed in the center column of the Specification Section. Limits, tolerances, and waveforms in this procedure are given as calibration guides and are not instrument specifications, unless given in the Specification Section.

RECOMMENDED TEST EQUIPMENT

General

The following test equipment, or its equivalent, is used for this procedure.

Specifications given are the minimum necessary for accurate evaluation of the 146. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended test equipment.

For ease and accuracy in performing the procedure, special calibration fixtures are used where necessary. All calibration fixtures listed are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Equipment Required

1. Test oscilloscope. Bandwidth, DC to at least 10 MHz; minimum deflection factor, 1 mV/division; DC offset voltage, 0 to 1 volt; two input channels providing choice of independent channel operation or differential operation; sweep magnification, X100. A Tektronix Type 547 oscilloscope with a Type 1A5 Plug-In unit was used in this procedure.

2. Variable Autotransformer. Must be capable of supplying at least 200 volt-amperes over a voltage range of 90 to 136 volts (180 to 272 volts for 230 volt operation). For example, General Radio W10MT3W Metered Variac Autotransformer.

3. Vectorscope. Tektronix Type 520 NTSC Vectorscope.

4. Digital Frequency Counter. Frequency to 5 MHz; accuracy 0.5 P/M ± 1.0 count. For example, Tektronix 7000 Series Oscilloscope with readout and 7D14 Digital Counter Plug-In Unit or Hewlett-Packard Model 5245L Electronic Counter.

5. Video Signal Source. Tektronix Type 140 or 146 NTSC Test Signal Generator recommended.

6. Tektronix Calibration Fixture 067-0596-00. Chopped Voltage Reference.

7. Coaxial Cable (six). Impedance, 75 Ω; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

8. Termination (three). Impedance, 75 Ω; connectors, BNC; type, end-line; accuracy, within 3%. Tektronix Part No. 011-0102-00.

PERFORMANCE CHECK PROCEDURE

General

The sequence of steps in the following procedure is arranged to check the instrument with minimum reconnection of equipment and calibration fixtures. Control settings or test equipment connections should not be changed except as noted.

If only a partial check is desired, refer to the preceding steps for setup information. All front and rear panel switches and connectors on the 146 are capitalized (e.g., FIELD DISPLAY) when referred to.

The procedure has been grouped into 11 blocks to allow related functions to be checked. For example; all checks relating to the staircase signal will be found under the heading of STAIRCASE. The following list may be used as an index to the complete Performance Check Procedure.

Each group of checks correspond to a like group in the Calibration Section, allowing the user to refer to the calibration adjustments should internal adjustment be necessary.

NOTE

All waveform illustrations in this procedure are actual photographs taken with a Tektronix Oscilloscope Projected Graticule Camera System.

Preliminary Procedure

1. Connect the autotransformer to a suitable power source, and the 146 to the autotransformer.

2. Set the autotransformer to the design center voltage for the LINE VOLTS selector switch position being used.

3. Set the 146 POWER switch to ON. Allow at least 20 minutes warmup at 25° C, ±5°C before checking the instrument to the given accuracy.

POWER SUPPLIES

1. Setup

Set the 146 switches to the STANDARD SIGNAL position, APL/IRE LEVEL switch to 50%, and the LINE switch to 15. Set the test oscilloscope for a sweep rate of 10 μs/div with negative external triggering. Set the Type 1A5 Display switch to A-Vc, A Input Coupling switch to DC, and the Volts/Cm switch to .2 V.

2. Check Shorting or Overload

a. CHECK—That the 146 POWER and OVEN TEMP NORMAL lights are on.

3. Check Regulation

a. From the 146 COMP VIDEO connector, connect a 75 ohm coaxial cable and a 75 Ω termination to the Type 1A5 A Input connector. Connect a 75 Ω coaxial cable from the COMP SYNC connector to the test oscilloscope Trigger Input connector.

b. Note test oscilloscope display amplitude and stability.

c. Observing the test oscilloscope display, vary the autotransformer output voltage between the high and low voltages listed on the 146 LINE VOLTS selector for the position being used.

d. CHECK—Test oscilloscope display amplitude and/or stability should not change as the autotransformer output voltage is varied.

e. Disconnect the autotransformer and reconnect the 146 to a suitable power source.

SUBCARRIER OSCILLATOR

1. Setup

Set the Type 1A5 A Input coupling switch to GND, and the Volts/Cm switch to the 50 mV position.

2. Check DC Level

a. Position the CRT trace to the graticule centerline, then switch the Type 1A5 A Input Coupling switch to DC.

b. CHECK—Blanking level of waveform should be within 1 cm (50 mV) of the reference established in step a.

3. Check Subcarrier Frequency

a. From the 146 SUBCARRIER connector, connect a 75 Ω coaxial cable to the Frequency Counter.

b. CHECK—Frequency should read within 5 Hz of 3.579545 MHz.

c. Disconnect the Frequency Counter from the 146 SUBCARRIER connector.

4. Check Subcarrier Amplitude & Linearity

a. Set the Type 1A5 Volts/Cm switch to .5 V and the A Coupling switch to AC.

b. Disconnect the 75 Ω coaxial cable from the 146 COMP VIDEO connector and reconnect it to the SUB-CARRIER connector.

c. CHECK—Display amplitude should be 2 volts peak to peak within 0.2 V (10%).

d. Observing the test oscilloscope display, rotate the Type 1A5 Position control to center the display about the graticule vertical centerline.

e. Set the Type 1A5 A Input Coupling switch to the DC position.

f. CHECK—Signal DC level (display center) should be within 4 mm of the graticule vertical centerline.

g. Disconnect the 75 Ω coaxial cable from the 146 SUB-CARRIER connector and reconnect it to the COMP VIDEO connector. Disconnect the 75 Ω coaxial cable from the COMP SYNC connector and reconnect it to the 146 rear-panel HORIZ DRIVE connector. (This triggers the test oscilloscope on the Horizontal Drive signal.)

MODULATOR

1. Setup

Place the 146 FIELD DISPLAY switch to FULL FIELD COLOR BARS position, the R—Y PHASE switch to ALT, and the remaining switches to STANDARD SIGNAL position. Set the Type 1A5 Volts/Cm selector to 10 mV position, the Polarity switch to — and the Vc Amplitude control to 0-0.

2. Check Sync Tip Aberration

a. Observing the test oscilloscope display, rotate the Type 1A5 Vc Amplitude control to view the sync tip.

b. CHECK—Aberration, near center of sync tip, should not exceed 32 mV peak to peak.

3. Check Modulator Phasing

a. From the 146 rear-panel COMP VIDEO connector, connect a 75 Ω coaxial cable to the Vectorscope CH A (J1) Input connector. Terminate the CH A (J2) Input connector with a 75 Ω end-line termination.

b. Depress the Vectorscope CH A, Full Field, AΦ and Vector pushbuttons. Then switch the 146 B—Y switch down.

c. CHECK—Vectorscope display; color dots should overlay within 0.5°. (Use the Vectorscope Calibrated Phase control to measure the error, if any.)

d. Switch the 146 R—Y switch down and the B—Y switch up.

e. CHECK—Vectorscope display; color dots should overlay within 0.5°.

f. Set the 146 R—Y switch up.

4. Check Chrominance Aberration

a. Set the 146 Y switch down and the SETUP switch to the 0% position. Set the Type 1A5 Volts/Cm switch to .1 V and the Polarity switch to 0. Set the test oscilloscope for a sweep rate of 5 μs/Div.

b. While observing the test oscilloscope display, adjust the Vertical and Horizontal Position controls to center the green-megenta transistion to the CRT center.

c. Depress and hold the 146 COLOR LOCK UNLOCK switch.

d. CHECK—Aberrations at both leading edges (positive and negative) of the magenta envelope should not exceed 40 mV.

5. Check Black Residual Subcarrier

a. Set the 146 Y switch up, the test oscilloscope for a sweep rate of 10 μs/Div, and the Type 1A5 Volts/Cm switch to 2 mV, the Polarity switch to + position.

b. Observing the test oscilloscope display, rotate the Type 1A5 Vc Amplitude control to view the blanking level.

c. CHECK—Residual subcarrier on blanking should not exceed 2.5 mV peak to peak.

COLOR BARS

1. Setup

Set the 146 Y switch down, AMPL switch to 100%, SETUP to 0%, FIELD DISPLAY to FULL FIELD COLOR BARS position, and the remaining switches in the STANDARD SIGNAL position. Set the Type 1A5

Volts/Cm selector to 10 mV and the Polarity to 0 position. Set the test oscilloscope Time/Cm to 5 µs and switch the Sweep Magnifier to X10 position.

2. Check Spurious Subcarrier

a. Position the blanking level of the display (which follows just after the burst envelope) into CRT graticule area with the Vertical and Horizontal Position controls.

b. CHECK—Spurious subcarrier amplitude should not exceed 32 mV peak to peak.

3. Check Quadrature Phasing

a. Set the Type 1A5 Volts/Cm to 5 mV, and the Polarity to + position. Set the test oscilloscope Time/Div to 5 µs and switch the Sweep Magnifier Off. Set the 146 R—Y PHASE switch to ALT position.

b. Observing the test oscilloscope display, rotate the Type 1A5 Vc Amplitude control so the peaks of the red and cyan envelopes can be observed.

c. CHECK—Envelopes should overlay within 2 mV. (Amplitudes will be the same in either 90° or 270° position of the 146 R—Y PHASE switch.)

4. Check Mod Subcarrier Component

a. Set the Type 1A5 Display switch to A-B, Polarity switch to 0, and the B Input Coupling switch to DC. Set the test oscilloscope sweep rate to 10 µs/div. Set the 146 VIDEO switch to its down position, MOD STAIRCASE switches down, APL/IRE LEVEL switch to 0, and the R—Y PHASE switch to 90°.

b. From the 067-0596-00 Calibration Fixture Chopped Output connector, connect a 75 Ω coaxial cable to the Type 1A5 B Input connector. Set the V1 Range switch to −1.1 V, V2 Range switch to +1.1 V, and both the V1 and V2 Volts controls for 286 mV.

NOTE

See 067-0596-00 Calibration Fixture instruction manual on how to set V1 and V2 controls for specified output voltages.

c. Observing the test oscilloscope display, rotate the V2 Volts control until the peaks of the largest envelope just meet.

d. CHECK—Amplitude should equal 572 mV within 3%.

5. Check Mod Subcarrier Duration

a. Set both V1 and V2 Range switches to 0 position. Set the Type 1A5 Display switch to A-Vc.

b. CHECK—Duration of first envelope should equal 13.2 µs within 0.5 µs.

6. Check Modulated Subcarrier Phase Error

a. CHECK—Vectorscope display; phase error between 572 mV and 286 mV vectors should be within 0.5° (see Fig. 5-1).

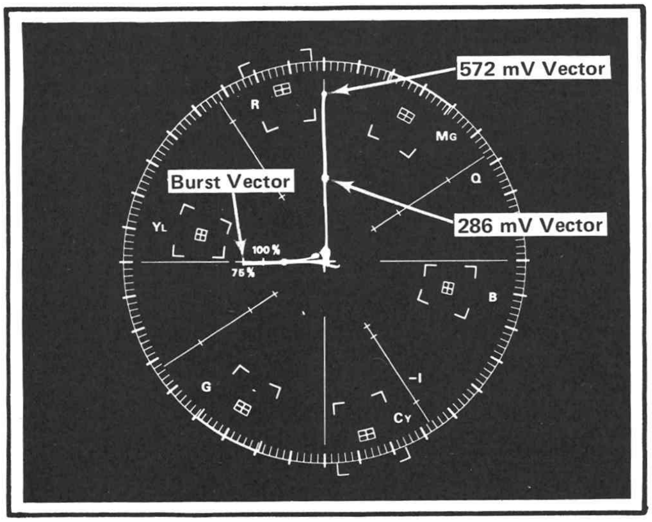


Fig. 5-1. Vectorscope display of modulated subcarrier.

7. Check Chrominance Levels

a. Set the 146 AMPL, SETUP, and VIDEO switches up. Set the V1 Range switch to −1.1 V, V2 Range switch to +1.1 V, and both the V1 and V2 Volts controls for 312.9 mV. Set the Type 1A5 Display Switch to A-B position.

b. Observing the test oscilloscope display, rotate the V2 Volts control until the peaks of the red and cyan envelopes just meet.

c. CHECK—Amplitude should be between 619.6 and 632.2 mV (625.9 mV, ±1%).

NOTE

To properly check the remaining chrominance levels an internal adjustment affecting all chrominance must be made. The following steps therefore should be performed by personnel familiar with internal adjustment procedures.

d. NOTE and RECORD both the V1 and V2 Volts control dial setting obtained in step b.

e. Remove the 146 top dust cover.

f. Set both the V1 and V2 Volts controls for 312.95 mV (625.9 mV).

g. ADJUST—R482 (see Fig. 5-2) until the peaks of the red and cyan envelopes just meet.

h. Set the 146 B—Y switch down.

i. Observing the test oscilloscope display, rotate the V1 and V2 Volts controls until the blue and yellow envelopes just meet.

j. CHECK—Amplitude should be between 94.1 and 97.4 mV (95.6 mV, ±1.5 mV).

k. Repeat step i using the green and magenta envelopes.

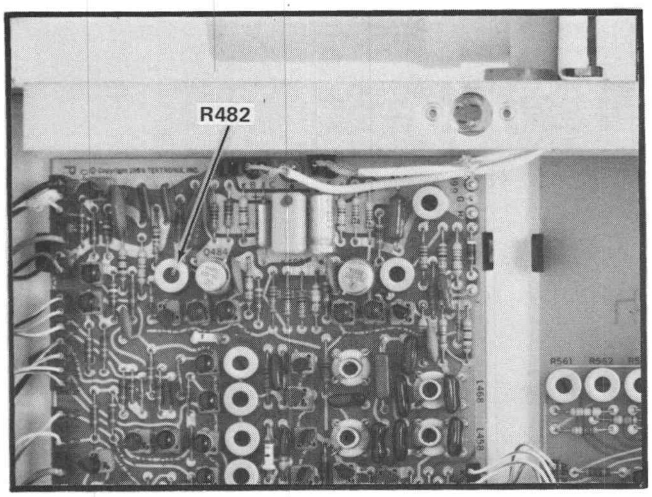


Fig. 5-2. Bar Drive and Video Out board adjustment location.

l. CHECK—Amplitude should be between 507.7 and 518.0 mV (512.9 mV, ±1%).

m. Repeat step i using the red and cyan envelopes.

n. CHECK—Amplitude should be between 602.4 and 614.6 mV (608.5 mV, ±1%).

o. Set the 146 R—Y switch down and the B—Y switch up.

p. Repeat steps i through n checking the following: Blue and yellow, 430.3 to 439.0 mV (434.7 mV, ±1%); green and magenta, 285.3 to 291.1 mV (288.2 mV, ±1%); red and cyan, 145.0 to 147.0 mV (145.5 mV, ±1.5 mV).

8. Check White Residual Subcarrier

a. Set the 146 R—Y and Y switches up, and the WHITE REF switch to 100 IRE. Set the Type 1A5 Display switch to A-Vc, Polarity switch to +, and the Volts/Cm switch to 2 mV. Observing the test oscilloscope display, rotate the Vc Amplitude control to view the white level.

b. CHECK—Peak to peak residual subcarrier on white level should not exceed 2.5 mV.

c. Observing the test oscilloscope display, set the 146 SETUP switch to 10% then 0% positions. (Return the SETUP switch to 7.5% position.)

d. CHECK—Peak to peak residual subcarrier on white level should not exceed 2.5 mV.

e. Set the 146 Y switch down and the WHITE REF switch up, then set the Type 1A5 Display switch to A-B, Volts/Cm switch to 10 mV, and the Polarity switch to 0 position.

f. Set both the 067-0596-00 Calibration Fixture V1 and V2 Volts controls to the exact setting NOTED and RECORDED in step 7d.

g. ADJUST—R482 until the peaks of the red and cyan chrominance envelopes just meet.

h. Replace the 146 top dust cover.

9. Check —I and Q Amplitudes

a. Set the 146 R—Y, B—Y, SETUP switches down, and the FIELD DISPLAY switch to EIA COLOR BARS position.

b. Observing the test oscilloscope display, rotate both the V1 and V2 Volts controls until the peaks of the —I chrominance envelopes just meet.

c. CHECK—Amplitude of —I chrominance should be between 277.1 and 294.3 mV peak to peak (285.7 mV, ±3%).

d. Repeat the procedure (steps b and c) using the Q chrominance envelope.

10. Check Burst Amplitude

a. Observing the test oscilloscope display, rotate both the V1 and V2 Volts controls until the peaks of the burst envelope just meet.

b. CHECK—Burst amplitude should be between 282.8 and 288.6 mV peak to peak (285.7 mV, ±1%).

STAIRCASE

1. Setup

Place the 146 VIDEO switch in STAIRCASE position, MOD STAIRCASE switches down, APL/IRE LEVEL switches to 100 and all remaining switches in the STANDARD SIGNAL position. Set the 067-0596-00 Calibration Fixture V1 Range switch to 0, V2 Range switch to —1.1 V and the V2 Volts control for 285.7 mV.

2. Check Sync Amplitude

a. While observing the test oscilloscope display, rotate the V2 Volts control until the sync tip level of the upper display is in alignment with the blanking level of the lower display. (Use the test oscilloscope Sweep Magnifier to expand the display if desired.)

b. CHECK—Sync amplitude should be between 282.8 and 288.6 mV (285.7 mV, ±1%).

3. Check Luminance DC Level

a. Set the Type 1A5 Display to A-Vc and the A coupling switch to the GND position. Vertically center the CRT trace with the Type 1A5 Position control, then set the Type 1A5 A Coupling switch to DC position.

b. CHECK—Blanking level of display should equal 0 volts, ±50 mV.

4. Check APL/IRE Level Switch

a. Set the 146 APL/IRE LEVEL switch to 0 and the 90° SUBCARRIER switch to OFF position. Set both V1 and V2 Volts controls on the Calibration Fixture to 0 volts. Set the Type 1A5 Display switch to A-B position.

b. Observing the test oscilloscope display, rotate the Position control to position the blanking level of the display to the CRT center.

c. Set the V2 Range switch to —1.1 V, and the V2 Volts control for 71.4 mV.

d. Set the 146 APL/IRE LEVEL switch to 10 and rotate the Type 1A5 Position control fully counterclockwise.

e. Observing the test oscilloscope display, rotate the V2 Volts control to align the 10 level with the blanking level.

f. CHECK—Amplitude should equal 71.4 mV within 2%.

g. Set the V2 Range switch to 0, and the V1 Range switch to +1.1 V. Center the Type 1A5 Position control.

h. Observing the test oscilloscope display, rotate the V1 Volts control to align the 10 level with the blanking level.

i. Set the 146 APL/IRE LEVEL switch to 20, then rotate the Type 1A5 Position control fully counterclockwise.

j. Set the V1 Range switch to —1.1 V and rotate the V1 Volts control until the blanking level and 20 level are aligned.

k. CHECK—Amplitude should equal 71.4 mV within 2%.

l. Using Table 5-1 as a guide, check all settings as listed.

TABLE 5-1

APL/IRE LEVEL	Type 1A5 Position	067-0596-00				Repeat Steps
		V1 RANGE	V1 VOLTS	V2 RANGE	V2 VOLTS	
20	Midrange	+1.1 V	≈142.8	0	≈71.4 mV	h
30	CCW	+1.1 V	≈142.8	−1.1 V	≈71.4 mV	j and k
30	Midrange	+1.1 V	≈214.2	0	≈71.4 mV	h
40	CCW	+1.1 V	≈214.2	−1.1 V	≈71.4 mV	j and k
40	Midrange	+1.1 V	≈285.6	0	≈71.4 mV	h
50	CCW	+1.1 V	≈285.6	−1.1 V	≈71.4 mV	j and k
50	Midrange	+1.1 V	≈357.0	0	≈71.4 mV	h
60	CCW	+1.1 V	≈357.0	−1.1 V	≈71.4 mV	j and k
60	Midrange	+1.1 V	≈428.4	0	≈71.4 mV	h
70	CCW	+1.1 V	≈428.4	−1.1 V	≈71.4 mV	j and k
70	Midrange	+1.1 V	≈499.8	0	≈71.4 mV	h
80	CCW	+1.1 V	≈499.8	−1.1 V	≈71.4 mV	j and k
80	Midrange	+1.1 V	≈571.2	0	≈71.4 mV	h
90	CCW	+1.1 V	≈571.2	−1.1 V	≈71.4 mV	j and k
90	Midrange	+1.1 V	≈642.6	0	≈71.4 mV	h
100	CCW	+1.1 V	≈642.6	−1.1 V	≈71.4 mV	j and k

5. Check Staircase Levels

a. Set the 146 APL/IRE LEVEL switch to 50%, and the STEPS switch to 10.

b. Set the V1 Range switch to 0 and the V2 Range switch to +1.1 V.

c. While observing the test oscilloscope display, roate the Type 1A5 Position control to align the blanking level of the upper display at the CRT center. (This will be used as the reference.)

d. Using Table 5-2, CHECK for 71.5 mV, ±3% between steps.

TABLE 5-2

10 STEP		5 STEP	
Step	V2 Volts	Step	V2 Volts
1	69.6 to 73.8	1	143.0 to 144.9
2	139.1 to 147.8	2	284.2 to 289.9
3	208.7 to 221.7	3	426.6 to 435.3
4	278.5 to 295.6	4	569.0 to 580.4
5	348.3 to 369.8	5	710.5 to 725.5
6	417.8 to 444.0		
7	487.6 to 517.8		
8	557.6 to 591.7		
9	627.2 to 666.0		
10	696.4 to 740.0		

e. Set the 146 STEPS switch to position 5.

f. Using Table 5-2, CHECK for 143 mV, ±1% between steps.

6. Check Staircase Risetime

a. Set the Type 1A5 Display switch to A-Vc position, the Volts/Cm and Variable control for a display amplitude of 5 cm between any two steps.

b. Set the test oscilloscope Time/Cm to 2 μs, Sweep Magnifier to X10 and Trigger Slope to + position.

c. CHECK—Risetime of staircase signal should equal 260 ns ±39 ns.

d. Change the STEPS switch to 10 and repeat this procedure to check staircase risetime (steps a through c).

7. Check Staircase Aberrations

a. Turn the test oscilloscope Sweep Magnifier Off. Change the Type 1A5 Volts/Cm to 20 mV (Variable control in Cal position).

b. CHECK—Aberrations (peak to peak), on the leading corner of the step, should not exceed 2% of the 71.5 mV step checked in step 5d.

c. Change the 146 STEPS to 5 and the Type 1A5 Volts/Cm switch to 50 mV position.

d. CHECK—Aberrations (peak to peak) on the leading corner of the step should not exceed 2% of the 143 mV step checked in step 5f.

8. Check Staircase Chrominance Amplitude

a. Set the 146 180° SUBCARRIER switch up and the STEPS switch OFF. Set the Type 1A5 Display selector to A-B and the Volts/Cm to 10 mV. Set the test oscilloscope Time/Div switch to 5 μs, Sweep Magnifier Off.

b. Adjust the V2 Volts control on the Calibration Fixture until the peaks of the 180° subcarrier envelope just meet.

c. CHECK—Amplitude of 180° subcarrier should equal 143 mV ±4.3 mV (3%).

9. Check Staircase Duration

a. Set the Type 1A5 Display switch to A-Vc. Set and adjust the Volts/Cm and Variable controls for a display amplitude of 5 cm between blanking level and the most positive excursion of the display.

b. CHECK—Modulation duration should equal 40 μs ±0.2 μs as measured at the 50% amplitude levels of the display.

10. Check Staircase Timing

a. Set the 146 180° SUBCARRIER switch down and the STEPS switch to 5. Set the Type 1A5 Volts/Cm switch to .2 V and the Variable (V/Cm) to Cal position. Set the test oscilloscope for B Intensified mode with A Time/Div at 2 μs and B Time/Div at 10 μs. Use negative slope triggering.

b. Observing the test oscilloscope display, rotate the Delay-Time Multiplier to intensify the blanking level of the display, then set the test oscilloscope for A Delayed mode.

c. CHECK—Blanking level duration should equal 13.2 μs, ±.7 μs.

d. Rotate the Delay Time Multiplier control to bring the White level into view.

e. CHECK—White level duration should equal 13.2 μs, ±.7 μs.

f. Now rotate the Delay Time Multiplier control to observe any step.

g. CHECK—Step duration should equal 6.6 μs within 0.3 μs.

h. Set the 146 STEPS switch to 10. Change the test oscilloscope A Time/Div selector to 1 μs.

i. Repeat the procedure to check white level and step. Use 9.9 μs, ±.5 μs for white level and 3.3 μs, ±.2 μs for step.

11. Check APL

a. Set the test oscilloscope for B mode at a sweep rate of .2 ms/div. Change to internal triggering.

b. CHECK—10 Step staircase signal on each active video line.

c. Set the 146 APL/IRE LEVEL switch to 0.

d. CHECK—10 step staircase signal every fifth active video line.

e. Observing the test oscilloscope display, rotate the APL/IRE LEVEL switch from 0 through 100.

f. CHECK—Variable APL on four of five active video lines.

LUMINANCE BARS

1. Setup

Place the R—Y, B—Y,and STEPS switches down, the FIELD DISPLAY switch to FULL FIELD COLOR BARS position and the remaining switches in the STANDARD SIGNAL position. Set the test oscilloscope Time/Cm to 10 μs. Trigger the test oscilloscope externally from the 146 HORIZ DRIVE. Set the Type 1A5 Display selector to A-B position and the Volts/Cm switch to 10 mV.

2. Check Luminance Amplitudes

a. Align the blanking level of the upper display to the CRT graticule centerline with the vertical Position control. (This establishes a reference for the following steps.)

b. While observing the test oscilloscope display, rotate the V2 Volts control until the black level of the lower display aligns with the reference established in step a.

c. CHECK—Black level should equal 53.6 mV, ±1.5 mV.

d. CHECK the remaining luminance amplitudes using Table 5-3 as a guide.

TABLE 5-3

Luminance Level	Amplitude	Allowable Error
Blue	108.1 mV	1.5 mV
Red	202.2 mV	2.0 mV
Magenta	256.7 mV	2.6 mV
Green	345.9 mV	3.5 mV
Cyan	400.4 mV	4.0 mV
Yellow	494.6 mV	5.0 mV
White	549.1 mV	5.5 mV

e. Place the 146 WHITE REF switch to 100 IRE position.

f. While observing the test oscilloscope display adjust the 100 IRE white level, with the Calibration Fixture V2 Volts control, until it is aligned with the reference level established in step a.

g. CHECK—100 IRE white amplitude should equal 714.3 mV ±7 mV.

3. Check I and Q White Level

a. Set the 146 FIELD DISPLAY to EIA COLOR BARS position.

b. Adjust the V2 Volts control to align the −I, W, Q, B white pulse to the reference established in step 2a.

c. CHECK—−I, W, Q, B white pulse level should equal 714.3 mV ±7 mV.

4. Check White Bar Risetime

a. Set the 146 FIELD DISPLAY to FULL FIELD COLOR BARS position. Set the Type 1A5 Display to A-Vc and adjust the Volts/Cm and Variable controls so the display amplitude between blanking level and white level is 5 cm. Set the test oscilloscope Time/Div to 2 μs and switch the Sweep Magnifier to X10 position (sweep rate of 20 ns/div).

b. CHECK—Risetime should equal 115 ns ±17 ns (15%).

5. Check White Bar Aberrations

a. Turn the test oscilloscope Sweep Magnifier Off.

b. CHECK—Aberration on leading top corner of the white pulse should not exceed 0.5 mm (1% of 5 cm display).

6. Check Sync Pulse Risetime

a. Position the sync pulse (with a 5 cm spacing between the blanking level and sync tip level) into the graticule area with the Vertical Position control.

b. Switch the test oscilloscope Sweep Magnifier to the X10 position.

c. CHECK—Sync pulse risetime should equal 115 ns ±17 ns or 15%.

7. Check Sync Aberrations

a. Turn the test oscilloscope Sweep Magnifier Off.

b. CHECK—Aberrations, on corner of leading edge of the sync pulse, should not exceed 1 mm (2%).

8. Check Full Field Bar Width

a. Set the test oscilloscope for B Intensified mode with an A sweep rate of 1 μs/div and a B sweep rate of 10 μs/div. Set the Type 1A5 Volts/Cm switch to .2 V and the Variable (Volts/Cm) to Cal position.

b. Observing the test oscilloscope display, rotate the Delay Time Multiplier control to intensify any luminance level between yellow and blue.

c. CHECK—Bar width should be 6.6 μs within 0.3 μs. (Use the test oscilloscope in the A Delayed mode.)

9. Check EIA Bar Width

a. Set the 146 FIELD DISPLAY switch to EIA COLOR BARS.

b. CHECK—–I, W, and Q bars for 9.4 µs ±0.47 µs (5%).

c. CHECK—Black portion of –I, W, Q, B should be 24 µs, ±1 µs.

10. Check Luminance to Chrominance Delay Time

a. Change the test oscilloscope display to B mode and switch the Sweep Magnifier to X10 position (sweep rate of .1 µs/div). Set the 146 FIELD DISPLAY to FULL FIELD COLOR BARS position. Adjust the Volts/Cm and Variable controls for a display amplitude of 2 cm, then center the transition between green and magenta to the graticule center line with the Vertical and Horizontal Position controls. (This establishes a reference point for the green to magenta transition.)

b. Switch the 146 R–Y and B–Y switches up and the Y switch down. Press in and hold the COLOR LOCK UNLOCK button; reposition the transition (vertically only) to the graticule center. Measure the delay between the reference established in step a and the present position of the crossover point.

c. CHECK—Delay must be within 20 ns of reference set in step a.

HORIZONTAL TIMING

1. Setup

Set the 146 R–Y and B–Y switches down, FIELD DISPLAY switch to FULL FIELD COLOR BARS, STEPS switch to OFF and the other switches to the STANDARD SIGNAL position. Set the test oscilloscope for A Delayed mode with an A sweep rate of 1 µs/div and a B sweep rate of 10 µs/Div (sweep Magnifier Off). Set the Type 1A5 Volts/Cm switch to .1 Volt.

2. Check Timing

a. Using Fig. 5-3 as a guide, CHECK the timing as listed in Table 5-4.

TABLE 5-4

Area To Be Checked	Check For	See Fig. 5-3
Interval Between Field Sync Pulses	4.3 to 4.7 µs	A
Equalizer Pulse	2.3 to 2.4 µs	B
Sync Pulse Width	4.66 to 4.76 µs	C
Breezeway	700 to 800 ns	D
Burst Width	2.2 to 2.4 µs	E
Front Porch	1.49 to 1.59 µs	F

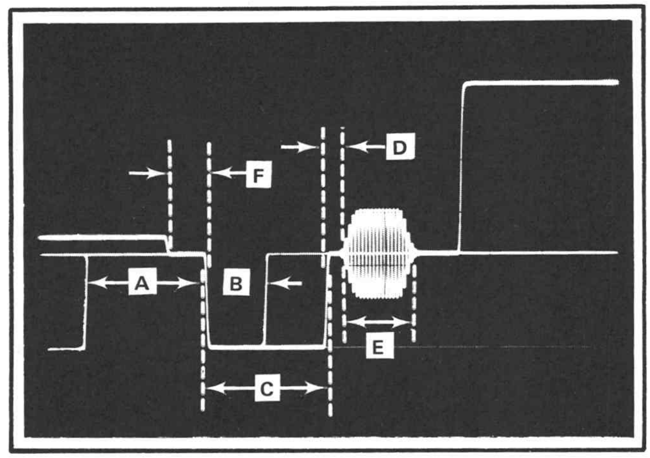


Fig. 5-3. Typical test oscilloscope display of the blanking interval.

VITS

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL Position, the APL/IRE LEVEL switch to 50%, and the LINE Switch to 15 position. Set the Type 1A5 Volts/Cm switch to .2 V position. Set the test oscilloscope for B intensified mode with an A sweep rate of .2 ms/div and a B sweep rate of 5 ms/div.

b. Disconnect the 75 Ω coaxial cable from the 146 rear-panel HORIZ DRIVE connector and reconnect it to the rear-panel VERT DRIVE connector. (This triggers the test oscilloscope from the Vertical Drive signal.)

2. Check VITS Line Switch

a. Observing the test oscilloscope display, rotate the Delay Time Multiplier to intensity one of the vertical blanking intervals.

b. Set the test oscilloscope for A delayed mode. Determine the field being displayed. This field can be identified by referring to Fig. 1-3 (see Specification Section).

c. Observing the test oscilloscope display, rotate the VITS LINE switch from 15 to 21.

d. CHECK—VITS must be on the line indicated by the VITS LINE switch.

3. Check VITS Signal Switch

a. Observing the test oscilloscope display, switch the VITS SIGNAL to OFF, then to COLOR BAR position.

b. CHECK—Test oscilloscope display of VITS should correspond to the VITS SIGNAL switch.

4. Check VITS Field Switch

a. While observing the test oscilloscope display, switch the VITS FIELD switch to BOTH then 2.

b. CHECK—Test oscilloscope display of VITS should correspond to the VITS FIELD switch.

CONVERGENCE PATTERN

1. Setup

Set the test oscilloscope for B mode at a sweep rate of 10 µs/div. Set the Type 1A5 Volts/Cm switch to 10 mV and the Display switch at A-B.

2. Check Convergence Amplitude

a. Disconnect the 75 Ω coaxial cable from the 146 COMP VIDEO connector and reconnect it to the CONVERGENCE PATTERN connector. Disconnect the 75 Ω coaxial cable from the rear-panel VERT DRIVE connector and reconnect it to the rear-panel HORIZ DRIVE connector. (Test oscilloscope is now triggered on Horizontal Drive signal.)

b. Align the blanking level of the upper display to the graticule center with the Vertical Position Control to establish a reference level.

c. Rotate the 067-0596-00 Calibration Fixture V2 Volts control until the top of the lower display aligns with the blanking level of the upper display.

d. CHECK—Peak amplitude should equal 549.1 mV, ±27.5 mV (±5%).

3. Check Setup Amplitude

a. Rotate the V2 Volts control until the setup level of the lower display aligns with the blanking level.

b. CHECK—Setup level should equal 53.6 mV, ±27 mV (±5%).

4. Check Sync Amplitude

a. Set the V2 Range switch to −1.1 V position. Rotate the V2 Volts control until the sync tip of the lower display is aligned with the blanking level.

b. CHECK—Sync amplitude should equal 286 mV, ±14.5 mV (±5%).

5. Check DC Level

a. Set the Type 1A5 Display switch to A-Vc position, Volts/Cm to .1 V and the A and B Input Coupling switches to GND. Center the trace vertically with the Position Control.

b. Switch the type 1A5 A Input Coupling switch to DC.

c. CHECK—Blanking level of the display should be within 100 mV of the reference established in Step a.

6. Check Risetime

a. Set the 146 CONVERGENCE CROSSHATCH switch to HORIZ position.

b. Adjust the Type 1A5 Volts/Cm and Variable (Volts/Cm) controls for a display amplitude of 5 cm between blanking and the peak of the display.

c. Switch the test oscilloscope B Time/Div to 2 µs and the Sweep Magnifier to X10 position (.2 µs/div).

d. CHECK—Risetime should equal 115 ns within 17 ns (15%).

7. Check Vertical Pulses

a. Set the test oscilloscope at a sweep rate of 10 µs/div and the Sweep Magnifier to Off. Set the Type 1A5 Volts/Cm to .1 V and the Variable (Volts/Cm) to Cal. Set the 146 CROSSHATCH switch to VERT and rotate the HORIZ POSITION control fully clockwise.

b. CHECK—There should be 17 pulses, with the first and last pulses an equal distance from the leading and trailing edges of setup.

c. Rotate the HORIZ POSITION control fully counterclockwise.

d. CHECK—There should be 16 or 17 pulses on the display.

8. Check Crosshatch Pulse Duration

a. Set the test oscilloscope for a sweep rate of 2 µs/div, the Sweep Magnifier to X10 position. Rotate the HORIZ POSITION control fully clockwise.

b. CHECK—Pulse duration should equal 225 ns within 15%, as measured between the 50% points between setup and the pulse peak.

9. Check HORIZ POSITION Range

a. Rotate the HORIZ POSITION control fully counterclockwise. Set the test oscilloscope Time/Cm switch to 10 μs.

b. While observing the test oscilloscope display, horizontally position the peak of any pulse to the CRT center.

c. Rotate the HORIZ POSITION control fully clockwise.

d. CHECK—Pulse should have moved at least 3.2 μs from the reference established in step b.

10. Check Dot Pulse Duration

a. Set the 146 DISPLAY switch to DOTS position. Set the test oscilloscope for a sweep rate of 2 μs/div.

b. CHECK—Dot pulse duration should be 350 ns within 15% as measured at the 50% points between setup and the pulse peak.

11. Check VERT POSITION Range

a. Disconnect the 75 Ω coaxial cable from the 146 rear-panel HORIZ DRIVE connector and reconnect it to the VERT DRIVE connector.

b. Set the 146 CROSSHATCH switch to HORIZ and rotate the VERT POSITION control fully counterclockwise. Set the test oscilloscope for a sweep rate of 2 ms/div, Sweep Magnifier to Off position.

c. Observing the test oscilloscope display, rotate the Horizontal Position control to position any pulse such that it starts at the CRT graticule center.

d. Rotate the VERT POSITION control fully clockwise.

e. CHECK—Pulse should have moved at least 1.1 ms from the reference established in step c.

GEN LOCK

1. Setup

Set the 146 switches to the STANDARD SIGNAL position. Set the test oscilloscope for a sweep rate of 10 μs/div. Set the Type 1A5 Volts/Cm to .2 V position.

2. Check Loss of Burst Indicator

a. Disconnect the 75 Ω coaxial cable from the CONVERGENCE PATTERN connector and reconnect it to the COMP VIDEO connector. Disconnect the 75 Ω coaxial cable on the rear-panel VERT DRIVE connector and reconnect it to the HORIZ DRIVE connector.

b. Observing the test oscilloscope display and the 146 front-panel, set the SYNCHRONIZATION REF switch to EXT STD.

c. CHECK—146 AUTO INT SUBCARRIER light is on and the display consists of sync and luminance only.

d. From an external video source, connect a 2 volt peak to peak subcarrier signal via a 75 Ω coaxial cable to the 146 rear-panel SUBCARRIER INPUT connector. Terminate the other Loop-Thru Input connector with a 75 ohm end-line termination.

e. CHECK—AUTO INT SUBCARRIER light is out and the display consists of composite video.

3. Check Loss of Sync Indicator

a. Set the 146 REF switch to COLOR GEN LOCK position.

b. CHECK—AUTO INT SYNC light and AUTO INT SUBCARRIER light is on; display consists of composite sync only.

c. From the external video source, connect composite video via a 75 Ω coaxial cable to the 146 rear-panel GEN LOCK INPUT connector. Terminate the other Loop-Thru Input connector with a 75 Ω end-line termination.

d. CHECK—AUTO INT SYNC and SUBCARRIER lights are out; display consists of composite video.

4. Adjust Line Sync Gen Lock Delay

a. Disconnect the 75 Ω end-line termination from the 146 rear-panel GEN LOCK Input connector. From the

GEN LOCK connector, connect a 75 Ω coaxial cable and a 75 Ω termination to the Type 1A5 B Input connector.

b. Set the test oscilloscope sweep rate for 1 μs/div.

c. While observing the test oscilloscope display, adjust the Type 1A5 Variable (Volts/Cm) control and Volts/Cm selector to obtain a display amplitude of 5 cm between the blanking level and the sync tip level.

d. While observing the test oscilloscope display, rotate the Horizontal Position control to align the 10% amplitude point on the leading edge of sync to a major graticule line. Do not move the Horizontal Position control for the remainder of this step.

e. Set the Type 1A5 Display switch to Vc-B and the B Input coupling switch to DC position, then vertically position the display to view the sync pulse.

f. While observing the test oscilloscope display, rotate the 146 front-panel LINE SYNC GEN LOCK DELAY control fully counterclockwise.

g. CHECK—Leading edge of sync pulse should be adjustable at least 1 μs from the reference established in step d.

h. While observing the test oscilloscope display, rotate the LINE SYNC GEN LOCK DELAY control fully clockwise.

i. CHECK—Leading edge of sync pulse should be adjustable at least 3 μs from the reference established in step d.

OTHER OUTPUTS

1. Setup

Set the 146 switches to the STANDARD SIGNAL position. Set the test oscilloscope for negative slope internal triggering. Set the Type 1A5 Display Selector to A-Vc, Volts/Cm to 1 V, Variable (Volts/Cm) to Cal, and the B Input Coupling to GND position.

2. Check Outputs

a. Using Table 5-5 as a guide, check all remaining outputs. All connections from 146 are via a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5.

b. Disconnect all test equipment. This completes the Performance Check.

TABLE 5-5

146 Output (front and/or rear)	Test Oscilloscope Time/Div: To Check Amplitude	Test Oscilloscope Time/Div: To Check Risetime	Check For: Amplitude	Check For: Risetime
COMP SYNC	10 μs	.1 μs	4 volts within 0.2 V	115 ns ±10%
HORIZ DRIVE	10 μs	.1 μs	4 volts within 0.2 V	115 ns ±10%
BURST FLAG	10 μs	.1 μs	4 volts within 0.2 V	115 ns ±10%
COMP BLANKING	10 μs	.1 μs	4 volts within 0.2 V	115 ns ±10%
VERT DRIVE	2 ms	.1 ms	4 volts within 0.2 V	115 ns ±10%

NOTES

SECTION 6
CALIBRATION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This procedure calibrates the instrument to the performance requirements listed in the Specification section. Limits, tolerances, and waveforms in this procedure are given as calibration guides and are not instrument specifications, unless given in the Specification section. The instrument should not require frequent calibration, but an occasional adjustment will be necessary when transistors, integrated circuits, and other components are changed. Also, a periodic recalibration is desirable from the standpoint of preventive maintenance. The calibration of the instrument should be checked after every 1000 hours of operation or each six months if the instrument is used intermittently.

TEST EQUIPMENT REQUIRED

General

All of the following test equipment, or its equivalent, is required for complete calibration of the 146.

Specifications given are the minimum necessary for accurate calibration. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For ease and accuracy in calibration, special calibration fixtures are used where necessary. All calibration fixtures listed are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Equipment List

1. DC Voltmeter. Accuracy, within ±0.1%; range, 3 to 15 volts. For example, Tektronix 7000 Series Oscilloscope with readout and 7D13 Digital Multimeter Plug-In Unit, or Fluke Model 825A.

2. Test Oscilloscope. Bandwidth, DC to at least 30 MHz; minimum deflection factor, 1 mV/division; DC offset voltage, 0 to 1 volt; two input channels providing choice of independent channel operation or differential operation; sweep magnification, X100. A Tektronix Type 547 oscilloscope with a Type 1A5 Plug-In unit was used for the Calibration procedure.

3. Variable Autotransformer. Must be capable of supplying at least 200 volt-amperes over a voltage range of 90 to 136 volts (180 to 272 volts for 230-volt nominal line). If the autotransformer does not have an AC Voltmeter to indicate output voltage, monitor output with an AC Voltmeter (RMS) with a range of at least 136 (or 272) volts. For example, General Radio W10MT3W Metered Variac Autotransformer.

4. Vectorscope. Measuring functions, differential gain and differential phase; accuracy, 0.5% and 0.1° respectively. Tektronix Type 520 or R520 Vectorscope recommended.

5. Constant Amplitude Signal Generator. Frequency, to 5 MHz; output amplitude, adjustable from about 0.5 volt to 2 volts; amplitude regulation, within 3%. Tektronix Type 191 Constant Amplitude Signal Generator recommended.

6. Electronic Digital Counter. Frequency, to 5 MHz. For example, Tektronix 7000 Series Oscilloscope with readout and 7D14 Digital Counter Plug-In Unit or Hewlett-Packard Model 5245L Electronic Counter.

7. Video Signal Source. Tektronix Type 140 or 146 NTSC Test Signal Generator recommended. A Type 140 was used for this Calibration procedure.

8. 067-0596-00 Chopped Voltage Reference. Tektronix calibration fixture 067-0596-00 recommended.

9. 011-0100-01 Voltage Step Up Termination. Tektronix Part No. 011-0100-01.

10. 015-0149-00 Return Loss Bridge. Tektronix calibration fixture 015-0149-00 recommended.

11. Probe. Attenuation, 10X; connector, BNC. For example, Tektronix Probe, P6008 Part No. 010-0219-00.

12. Probe. Attenuation, 1X; connector, BNC. Tektronix Probe P6028 recommended. Tektronix Part No. 010-0074-00.

13. Coaxial Cable (six). Impedance, 75 Ω; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

14. Termination (three). Impedance, 75 Ω; connector, BNC; type, end-line; accuracy, within 3%. Tektronix Part No. 011-0102-00.

15. Termination (two). Impedance, 75 Ω; connector, BNC; type, feedthrough; accuracy, matched to within 0.2%. Tektronix Part No. 011-0103-00 and 011-0103-01 (supplied with Tektronix 015-0149-00 calibration fixture).

16. Attenuator. Impedance 75 Ω; attenuation 10X. Tektronix Part No. 011-0062-00.

17. Attenuator. Impedance, 50 Ω to 75 Ω; connectors, BNC; type, minimum loss going from a 50 Ω system to a 75 Ω system. Tektronix Part No. 011-0057-00.

18. Jumper wire (3 inches long) with small insulated alligator clips.

19. Adjustment Tools

Description	Tektronix Part No.
a. Tuning tool:	
Handle; nylon	003-0307-00
Insert; 0.077-inch diameter, for 5/64-inch inside hex cores.	003-0310-00
b. Rod; 5 inches long, plastic, for 0.100-inch diameter powered iron hex cores.	003-0301-00
c. Adjustment tool; 1 1/2-inch shaft, 5 inches total length, plastic shaft and handle, and metal screwdriver tip.	003-0000-00
d. Screwdriver; 3/32-inch bit width, 3/32-inch diameter round shank, 5 inches long with plastic handle.	003-0192-00

CALIBRATION RECORD AND INDEX

This short-form procedure is provided to aid in checking the calibration of the 146. It may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers and titles correspond to those in the complete procedure, this procedure also serves as an index to the complete calibration procedure.

SHORT FORM CALIBRATION PROCEDURE

CALIBRATION PROCEDURE

General

The following procedure is arranged in a sequence designed for calibration with minimum interaction of adjustments. However, some adjustments affect the calibration of other circuits within the instrument, and it may be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked are noted in the "INTERACTION" step.

NOTE

If adjustments are made on the power supplies, the calibration of the entire instrument must be checked.

Do not preset internal controls unless the instrument has been repaired or is known to be seriously out of adjustment. If repairs have been made, preset internal controls to midrange in the affected circuits.

Failure of any circuit to meet the prescribed tolerances, checks, or adjustments indicates circuit malfunction which should be repaired before proceeding with this calibration procedure.

In the following procedure the 146 front-panel and rear-panel control titles and output connectors are capitalized (e.g., COMP SYNC). Internal adjustment titles are initial capitalized only (e.g., Bar Width). Unless stated otherwise, all connections are made to the 146 front-panel connectors.

The following procedure uses the equipment and fixtures previously listed in this section of the manual. If equipment and fixtures are substituted, control settings or test equipment setup may need to be altered to meet the requirements of the equipment used.

NOTE

All waveforms shown in this procedure are actual photographs taken with a Tektronix Oscilloscope Projected Graticule Camera System.

Preliminary Procedure

1. Remove the 146 from any enclosure so as to provide access to all internal adjustments and test points, including rear-panel connectors.

2. Lay the 146 on its side for access to the Power Supply board.

3. Connect the autotransformer to a suitable power source and the 146 to the autotransformer output.

4. Set the autotransformer output voltage to the design center voltage for which the 146 LINE VOLTS selector switch has been set.

5. Set the 146 POWER switch to ON. Allow at least 20 minutes warmup at 25°C, ±5°C before checking and/or calibrating the instrument to the given accuracy.

6. Set the 146 switches to the STANDARD SIGNAL POSITION.

POWER SUPPLIES

Tolerances listed for these steps are not instrument specifications, but serve as guides to determine whether complete instrument calibration is necessary. If a complete calibration is being performed, set each voltage to the exact setting. If you are performing a partial calibration, remember that an adjustment of any supply voltage may affect the operation of other circuits within the instrument. We therefore recommend no adjustments of the power supply voltages if they are within the listed tolerance.

1. Check Shorting or Overload

a. CHECK—POWER and OVEN TEMP NORMAL lights are on.

2. Check/Adjust Power Supply Voltages

a. Connect the precision DC Voltmeter between chassis ground and the junction of R887 and C885 (−15 volts), see Fig. 6-1.

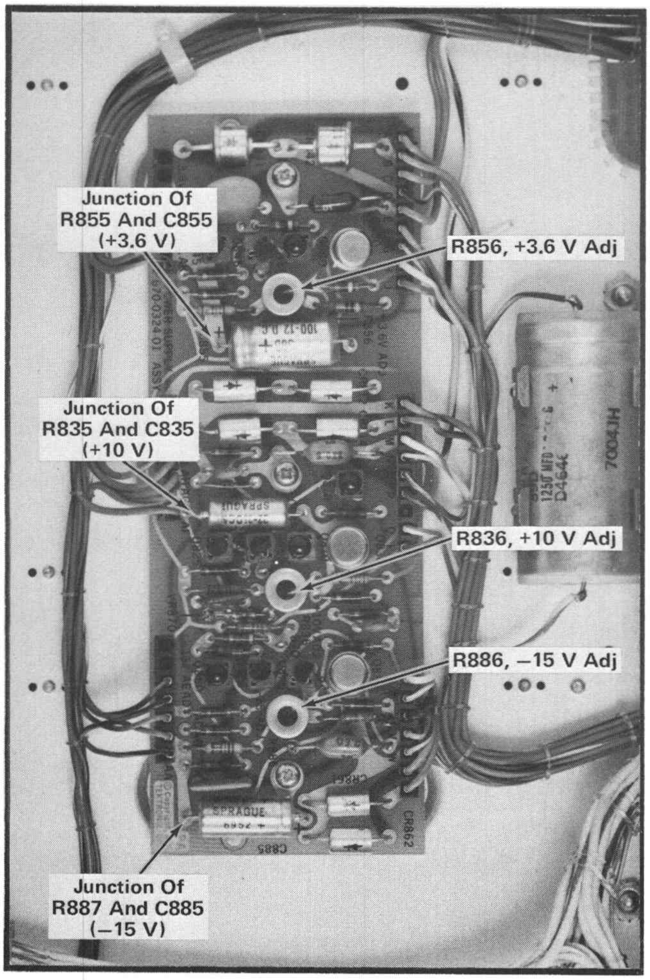


Fig. 6-1. Power Supply board adjustment and test point locations.

b. CHECK— −15 volts, ±1%.

c. ADJUST—R886, −15 V Adj, for −15 volts.

d. Connect the voltmeter between chassis ground and the junction of R855 and C855 (+3.6 volts).

e. CHECK—+3.6 volts, ±1%.

f. ADJUST—R856, +3.6 V Adj, for +3.6 volts.

g. Connect the voltmeter between chassis ground and the junction of R835 and C835 (+10 volts).

h. CHECK— +10 volts, ±1%.

i. ADJUST—R836, +10 V Adj. for +10 volts.

j. Repeat the above adjustment steps because of interaction.

3. Check Power Supply Regulation

a. Set the autotransformer output voltage in turn to the low and high voltages listed for the LINE VOLTS selector switch position being used.

b. CHECK— +10 volts within 1% at each autotransformer output voltage setting.

c. Repeat the above procedure for the +3.6 and −15 volt power supplies.

d. Disconnect the DC Voltmeter.

4. Check Power Supply Ripple

a. From the junction of R887 and C885, connect a 1X probe to the A Input connector of the Differential Comparator (Type 1A5).

b. Set the test oscilloscope for a sweep rate of 5 ms/div. Use line triggering.

c. Switch the Type 1A5 A Input coupling to Ac, Display to A-Vc, and the Volts/Cm switch to 10 mV position.

d. While observing the test oscilloscope display, change the autotransformer output voltage through the voltage range listed for the LINE VOLTS selector position being used.

e. CHECK—Ripple voltage should not exceed 10 mV peak to peak.

f. Check ripple voltage content on the +3.6 V and +10 V supplies using the above procedure. Must not exceed 10 mV peak to peak.

g. Disconnect all test equipment and connect the 146 directly to a suitable power source.

SUBCARRIER OSCILLATOR

1. Check/Adjust DC Level

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input connector. Connect another 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector.

b. Set the Type 1A5 A Input coupling switch to GND, Volts/Cm switch to 50 mV, then position the CRT trace vertically to the graticule center to establish a reference point.

c. Set the test oscilloscope for a sweep rate of 10 μs/Div; use external triggering with negative slope. Set the Type 1A5 A Input coupling switch to DC.

d. CHECK—Blanking level of display should be within 50 mV of 0 volts.

e. ADJUST—R478, Luminance DC Bal, to position the blanking level of the display to the reference established in step b (see Fig. 6-2).

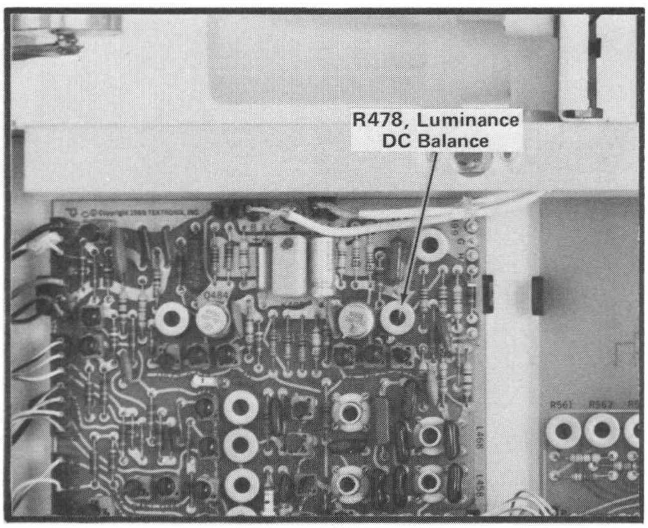


Fig. 6-2. Bar Drive and Video Out board adjustment location.

2. Check/Preset L217

a. Set the 146 R—Y and B—Y switches down and the FIELD DISPLAY switch to FULL FIELD COLOR BARS position.

b. CHECK—Black bar width should be 6.6 μs within 0.5 μs.

c. ADJUST—L217, Bar Width, (see Fig. 6-3) for a black level width of 6.6 μs. (This adjustment is not critical at this time.)

3. Check/Adjust Subcarrier Frequency

a. From the 146 SUBCARRIER connector, connect a 75 Ω coaxial cable to the frequency counter.

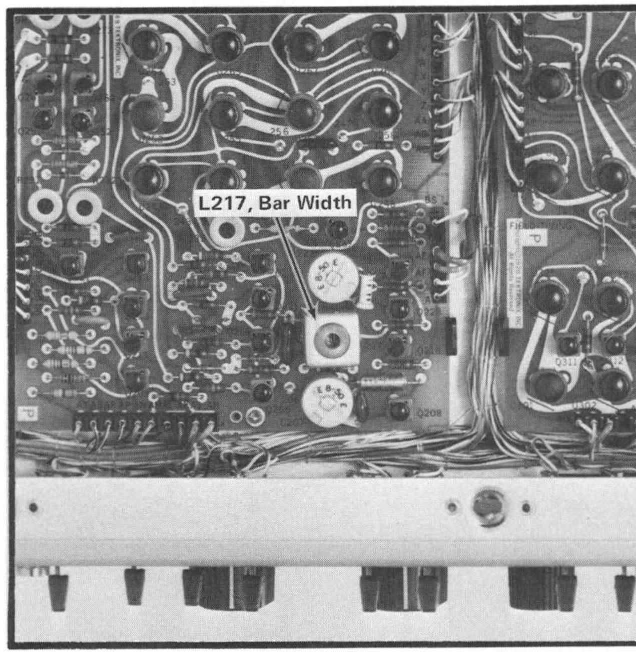


Fig. 6-3. Bar Timing board adjustment location.

b. CHECK—Subcarrier frequency should be within 5 Hz of 3.579545 MHz.

c. ADJUST—R5515, Freq Adj, (see Fig. 6-4) for 3.579545 MHz.

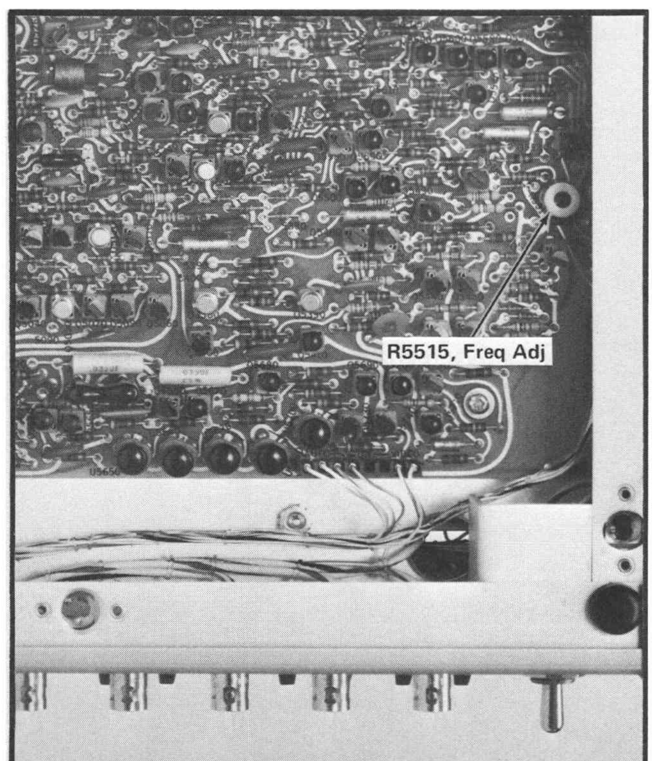


Fig. 6-4. Gen Lock board adjustment location.

d. Disconnect the 75 Ω coaxial cable from the 146 and frequency counter.

4. Check/Adjust Subcarrier Amplitude & Linearity

a. Disconnect the 75 Ω coaxial cable from the COMP VIDEO connector and reconnect it to the SUBCARRIER connector.

b. Set the Type 1A5 A Input coupling switch to GND, Volts/cm to .5 V, then vertically center the CRT trace.

c. Switch the Type 1A5 A coupling switch to AC position.

d. CHECK—Subcarrier amplitude should equal 2 volts peak to peak within 10%.

e. ADJUST—L1147 and L1197 (see Fig. 6-5) for maximum subcarrier amplitude.

f. Amplitude should equal 2 volts ±0.2 V.

g. Switch the Type 1A5 A Input coupling to DC position.

h. CHECK—Signal DC reference level should be within 0.2 volt from the reference established in step b.

i. Disconnect all test equipment.

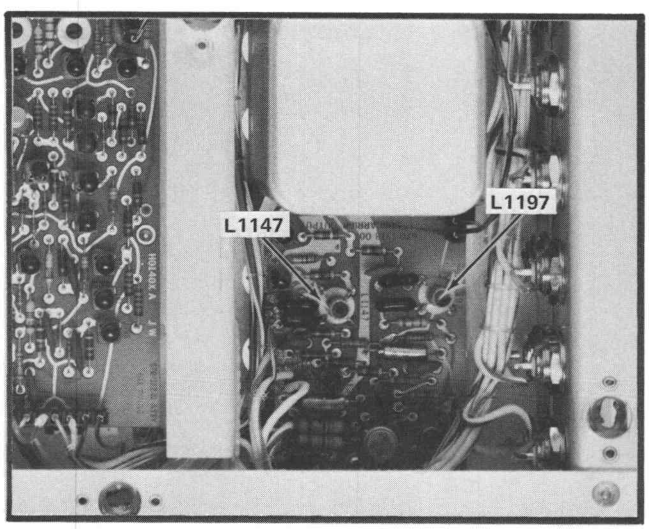


Fig. 6-5. Subcarrier Output board adjustment locations.

MODULATOR

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL POSITION except, set the FIELD DISPLAY switch to FULL FIELD COLOR BARS.

b. Connect a 75 Ω coaxial cable from the 146 rear-panel HORIZ DRIVE connector to the test oscilloscope trigger input connector.

c. Set the test oscilloscope for a sweep rate of 10 μs/Div. Use external triggering from 146 HORIZONTAL DRIVE signal.

d. Set the Type 1A5 A Input coupling switch to AC and the Volts/Cm switch to 5 mV position.

2. Adjust Filters

a. Connect a properly compensated 10X probe from TP188 on the Demodulator board (see Fig. 6-6) to the Type 1A5 A Input connector.

b. Adjust—L187 for optimum square corner response on the displayed waveform.

c. Connect the 10X probe to TP168; then ADJUST L167 for optimum square corners on the displayed waveform.

d. Set the Type 1A5 Volts/Cm switch to 10 mV position; then connect the 10X probe to TP182.

e. ADJUST—L183 for optimum square corner on the displayed waveform.

f. Connect the 10X probe to TP162, then ADJUST L163 for optimum square corner on the displayed waveform.

g. Disconnect the 10X probe.

3. Check Sync Tip Aberration

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and a 75 Ω termination to the Type 1A5 A Input connector.

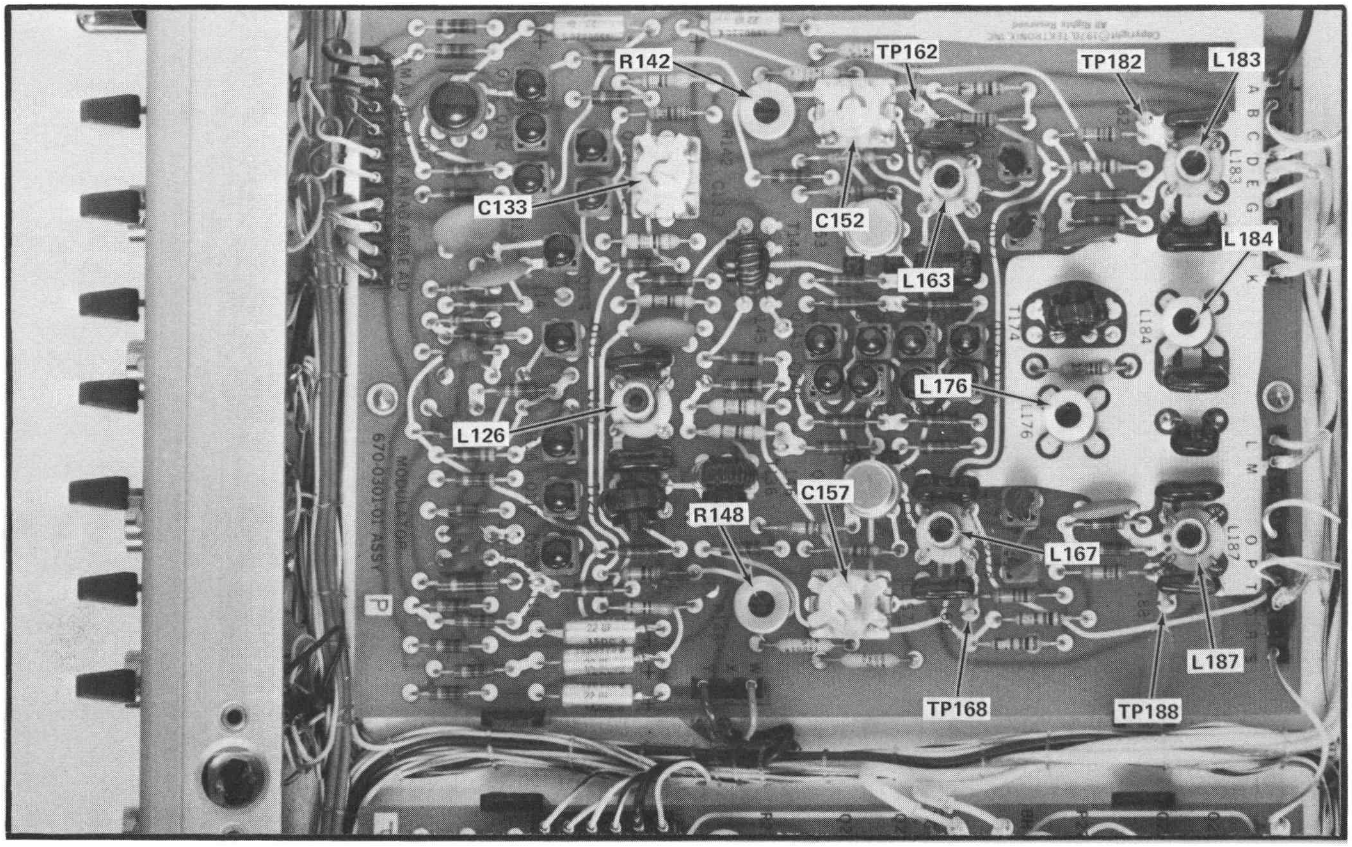


Fig. 6-6. Demodulator board test point and adjustment locations.

b. Switch the Type 1A5 A input coupling to DC, and the Polarity to the – position. Set the 146 R–Y PHASE switch to ALT.

c. Observing the test oscilloscope display, rotate the Type 1A5 Vc Amplitude control to position the sync tip into view.

d. CHECK—Aberrations, at center of sync tip, should not exceed 32 mV peak to peak.

4. Adjust Chroma Null

a. Switch the Type 1A5 Polarity to 0 and set the Volts/Cm switch to 2 mV position.

b. Set the 146 R–Y, B–Y, Y and SETUP switches down.

c. ADJUST—C152, C157, R142, and R148 (see Fig. 6-6) for a chroma null. (Disregard switching transients typically 2 mV after null.) See Fig. 6-7.

5. Check/Adjust Vertical and Horizontal Overlay

a. From the 146 rear-panel COMP VIDEO connector, connect a 75 Ω coaxial cable to the Vectorscope CH A (J1) input connector. Terminate the unused CH A (J2) input connector with a 75 Ω end-line termination. Adjust the Vectorscope controls to obtain a vector display.

b. Set the 146 R–Y switch up.

c. CHECK—Dots along the R–Y axis (90°-270°) should overlay within 0.5°. (Use the Vectorscope Calibrated Phase control to measure the error.)

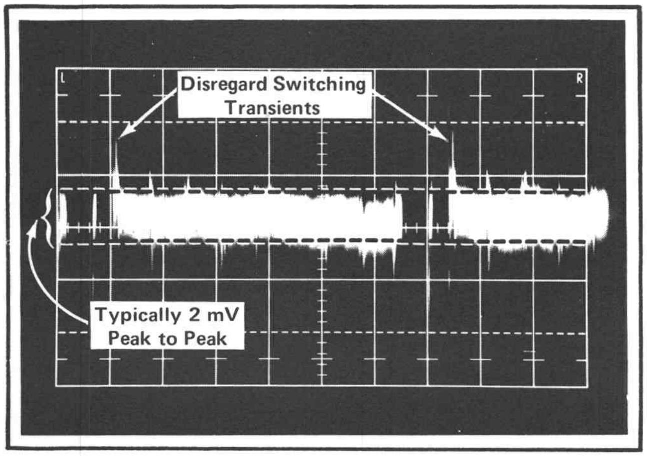


Fig. 6-7. Typical test oscilloscope display obtained after adjustment of chroma null.

d. ADJUST—C133 (see Fig. 6-6) for best overlay of dots.

e. Set the 146 B—Y switch up and the R—Y switch down.

f. CHECK—Dots along the B—Y axis should overlay within 0.5°.

g. Repeat steps b through f because of interaction until the best overlay of dots is obtained on both axes.

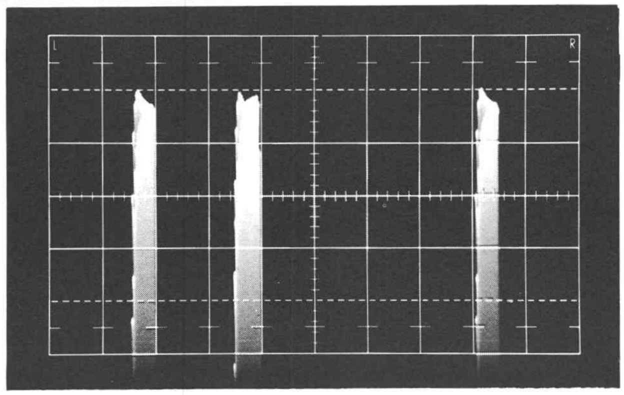
6. Adjust Quadrature Phasing

a. Set the 146 R—Y and B—Y switches up.

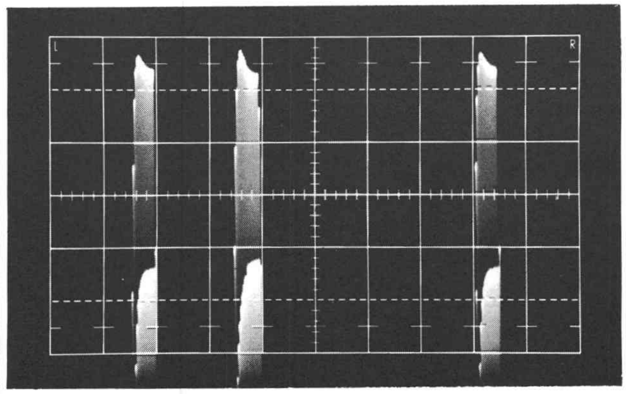
b. Set the sweep rate of the test oscilloscope for 5 µs/div.

c. Switch the Type 1A5 Comparison Voltage Polarity switch to + and the Volts/Cm selector to 5 mV. Rotate the Vc Amplitude control to position the peaks of the red and cyan chroma into view on the CRT (see Fig. 6-8A and B).

d. ADJUST—L126 (see Fig. 6-6) to overlay the chrominance.



(A) Correct color bar phasing.



(B) Incorrect color bar phasing.

Fig. 6-8. Typical test oscilloscope displays showing (A) correct and (B) incorrect adjustment of quadrature phasing.

e. Set the Type 1A5 Polarity switch to — position.

f. Repeat step d using the negative peaks of the chroma.

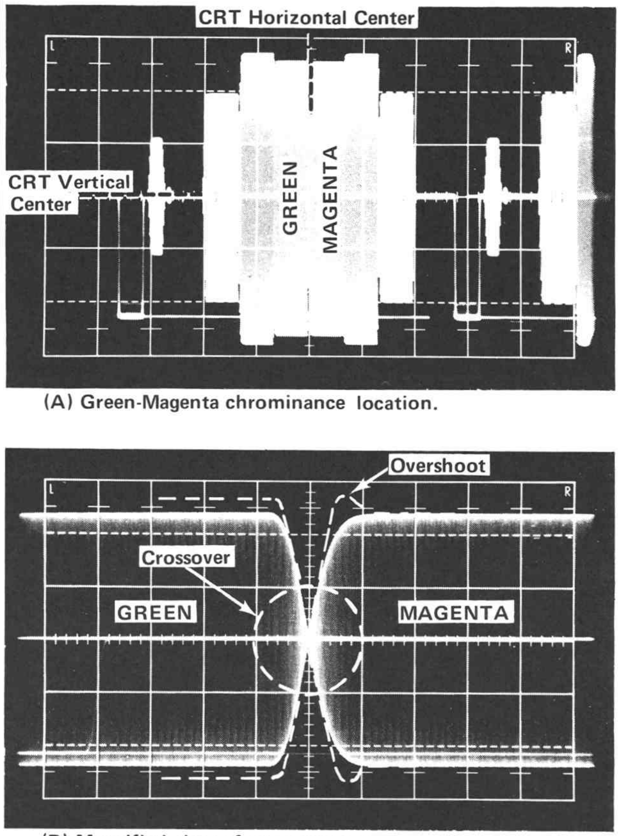
7. Adjust Chrominance Filter

a. Set the Type 1A5 Polarity switch to 0 and the Volts/Cm switch to .1 V position.

b. Set the sweep rate of the test oscilloscope for 10 µs/div.

c. Observing the test oscilloscope display, rotate the Type 1A5 Position control and the test oscilloscope Horizontal Position control to center the green-magenta transistion vertically and horizontally on the CRT (see Fig. 6-9A), then switch the test oscilloscope Sweep Magnifier to X10 position.

d. Observing the test oscilloscope display, press in and hold the 146 COLOR LOCK UNLOCK switch.



(A) Green-Magenta chrominance location.

(B) Magnified view of green-magenta transition.

Fig. 6-9. Typical test oscilloscope displays obtained to adjust the chrominance filter.

e. ADJUST—L176 and L184 (see Fig. 6-6) for minimum overshoot, overlay, and crossover of the chrominance envelope; see Fig. 6-9B.

NOTE

Adjustment of L176 and L184 affect overall chrominance amplitude. See COLOR BAR section.

8. Check Black Residual Subcarrier

a. Set the 146 Y switch up.

b. Set the test oscilloscope Sweep Magnifier to X1 position.

c. Set the Type 1A5 Polarity switch to + and Volts/Cm switch to 2 mV position. Rotate the Vc Amplitude control to position the blanking level of the display into view.

d. CHECK—Residual subcarrier on the blanking level should not exceed 2.5 mV peak to peak.

9. Adjust C422 and C427

a. Set the 146 Y switch down, AMPL switch to 100%, and the R—Y PHASE switch to 90°.

b. Set the test oscilloscope Sweep Magnifier to X10 position.

c. Set the Type 1A5 Volts/Cm switch to 10 mV and the Polarity switch to 0 position. Set the blanking level of the display to the CRT center with the Position control.

d. ADJUST—C422 and C427 (see Fig. 6-10) for minimum 3.58 MHz aberration following just after burst.

10. Readjust Quadrature Phasing

a. Set the test oscilloscope for a sweep rate of 5 µs/Div (Sweep Magnifier X1).

b. Set the Type 1A5 Volts/Cm to 5 mV position and the Polarity switch to + position. Rotate the Vc Amplitude control to position the peaks of the chrominance envelopes into view.

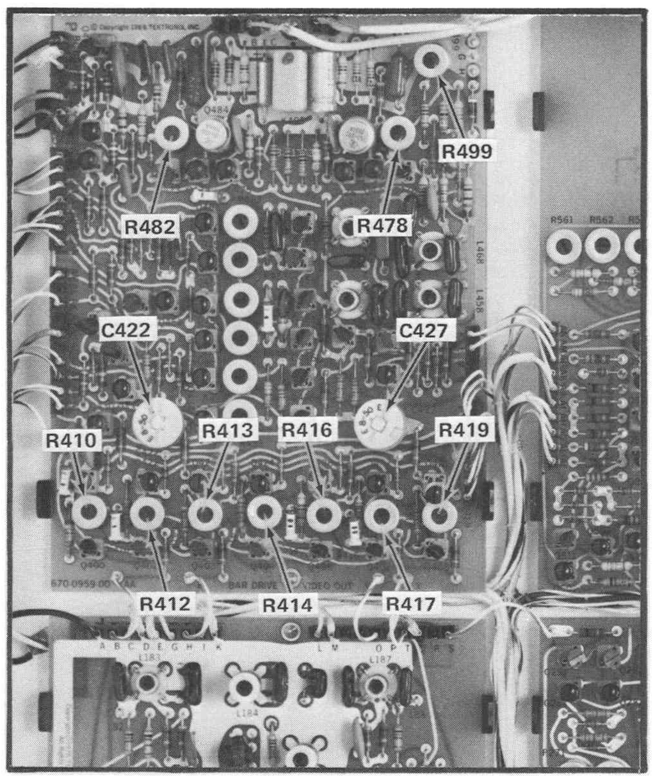


Fig. 6-10. Bar Drive and Video Out board adjustment locations.

c. Set the 146 R-Y PHASE switch to ALT.

d. CHECK—Chrominance envelopes should overlay within 2.5 mV.

e. READJUST—L126 (see Fig. 6-6) to overlay the chrominance envelopes within 2.5 mV.

f. Disconnect all test equipment.

COLOR BAR

1. Setup

a. Set the 146 FIELD DISPLAY to FULL FIELD COLOR BARS, VIDEO switch down, all STAIRCASE switches down, the APL/IRE LEVEL to 50%, and the remaining front panel switches to the STANDARD SIGNAL position.

b. Set the test oscilloscope for a sweep rate of 10 µs/Div with negative external triggering.

c. Set the Type 1A5 A and B Input coupling switches to DC, Volts/Cm to 10 mV and the Display switch to A-B.

d. Set the 067-0596-00 calibration fixture V1 Range switch to −1.1 V, and V2 Range switch to +1.1 V positions.

2. Adjust Mod Subcarrier

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input. Connect a 75 Ω coaxial cable from the HORIZ DRIVE connector to the test oscilloscope Trigger Input connector.

b. From the 067-0596-00 Calibration Fixture Chopped Output connector, connect a 75 Ω coaxial cable to the Type 1A5 B Input connector.

c. Observing the test oscilloscope display, rotate both V1 and V2 Volts controls on the Calibration Fixture until the peaks of the largest envelope just meet.

d. CHECK—Amplitude should equal 572 mV within 3%. (See 067-0596-00 Calibration Fixture, Chopped Voltage Reference, manual to determine voltage amplitude.)

e. Set both the V1 and V2 Volts controls for 286 mV (572 mV); ADJUST—R482, (see Fig. 6-10) until the upper and lower envelopes just meet.

NOTE

If the requirement is not met, repeat MODULATOR step 7 (Adjust Chrominance Filter); then repeat step 2 before proceeding.

3. Check Mod Subcarrier

a. Observing the test oscilloscope, rotate both the V1 and V2 Volts controls until the peaks of the next envelope just meet.

b. CHECK—Amplitude should equal 286 mV within 3%.

c. Repeat the procedure for the 1st envelope.

d. CHECK—Amplitude should equal 30 mV within 5 mV.

4. Check Unmod Subcarrier

a. Set the 146 90° SUBCARRIER switch to UNMOD position.

b. Observing the test oscilloscope display, rotate both the V1 and V2 Volts controls until the peaks of the modulation envelope just meet.

c. CHECK—Amplitude should equal 30 mV within 5 mV.

5. Check Modulated Subcarrier Phase Error

a. From the 146 rear-panel COMP VIDEO connector, connect a 75 Ω coaxial cable to the Vectorscope CH A (J1) Input connector. Connect a 75 Ω end-line termination to the other CH A (J2) Input connector.

b. Set the 146 90° SUBCARRIER switch to MOD position.

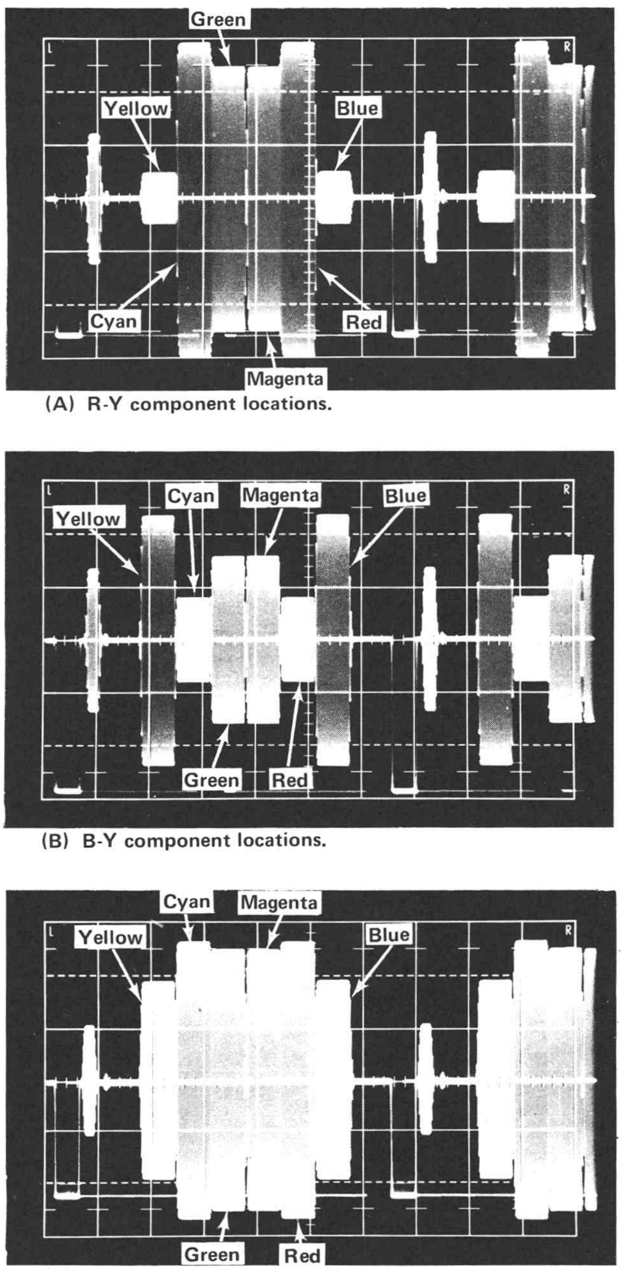
c. CHECK—Phase error between 572 mV and 286 mV should not exceed 0.5°. (Use the Vectorscope Calibrated Phase control to measure the error.)

6. Check/Adjust Chrominance Levels

a. Set the 146 B—Y and Y switches down, and the VIDEO switch to the STANDARD SIGNAL position.

b. Observing the test oscilloscope display, rotate the Calibration Fixture V1 and V2 Volts controls until the peaks of the blue chrominance envelope just meet. (See Fig. 6-11A.)

c. CHECK—Amplitude of R—Y blue should equal 95.6 mV within 1.5 mV.



(A) R-Y component locations.

(B) B-Y component locations.

(C) Chrominance component locations.

Fig. 6-11. Typical test oscilloscope displays of R—Y, B—Y, and Chrominance signal components.

d. Set both the V1 and V2 Volts controls for 47.8 mV (95.6 mV). ADJUST—R410 (see Fig. 6-10) until the peaks of the blue envelope just meet.

e. Rotate the V1 and V2 Volts controls until the green chrominance envelope peaks just meet.

f. CHECK—Amplitude of R—Y green should equal 512.9 mV within 1%.

g. Set both the V1 and V2 Volts controls for 256.45 mV (512.9 mV). ADJUST—R412 until the peaks of the green envelope just meet.

h. Set the 146 Y switch up.

i. Set the Type 1A5 Display switch to A-Vc, and the Polarity switch to + position. While observing the test oscilloscope display, rotate the Vc Amplitude control to position the white level into view.

j. CHECK—Chrominance on white level should not exceed 2.5 mV.

k. ADJUST—R413 for minimum chrominance on the white level.

l. Set the 146 R—Y and Y switches down. Set the B—Y switch up.

m. Set the Type 1A5 Display switch to A-B position.

n. Repeat the above procedure for the B—Y amplitudes (see Fig. 6-11B for B—Y component locations). Use the following amplitudes and adjustments: Blue—434.7 mV, ±1%—R419; green—288.2 mV, ±1%—R417; white—R416.

o. Repeat the above procedure (steps a-n) because of interaction between adjustments.

7. Check White Residual Subcarrier

a. Set the R—Y and B—Y switches up.

b. Observing the test oscilloscope display, rotate the Vc Amplitude control to position the white level into view.

c. Check—Subcarrier on white level should not exceed 2.5 mV peak to peak.

8. Check Chrominance Amplitudes

Using Table 6-1 as a guide, check the chrominance amplitudes. (See Fig. 6-11C for chrominance component locations.)

9. Check/Adjust —I and Q Chrominance

a. Set the 146 R—Y, B—Y, Y, and SETUP switches down. Set the FIELD DISPLAY switch to EIA COLOR BARS. Remove Q262; see Fig. 6-12.

b. Set both V1 and V2 Volts controls on the Calibration Fixture for 77.8 mV each.

c. Observing the test oscilloscope display, rotate the V2 Volts control until the I chrominance envelope peaks just meet.

d. CHECK—Amplitude should equal 155.6 mV within 1%.

e. Reset V1 and V2 controls for 77.8 mV each, then ADJUST—R272 until the peaks just meet.

f. Replace Q262 and remove Q292.

g. Repeat procedure of steps c-g using an amplitude of 119.8 mV and adjusting R232 (239.6 mV, ±1%).

h. Replace Q292 and remove Q261 then repeat the procedure using an amplitude of 119.8 mV, and adjust R271 for the Q chrominance level.

TABLE 6-1

Component	Chrominance (mV P-P)	146 Switch Settings				
		R-Y	B-Y	Y	AMPL	SETUP
Blue	445.1 within 1%	Up	Up	Down	75%	0%
Red	625.9 within 1%	Up	Up	Down	75%	0%
Magenta	588.3 within 1%	Up	Up	Down	75%	0%
Green	588.3 within 1%	Up	Up	Down	75%	0%
Cyan	625.9 within 1%	Up	Up	Down	75%	0%
Yellow	445.1 within 1%	Up	Up	Down	75%	0%
Blue	93.0 within 1.5	Up	Down	Down	75%	10%
Green	499.1 within 1%	Up	Down	Down	75%	10%
Red	592.1 within 1%	Up	Down	Down	75%	10%
Red	142.6 within 1.5	Down	Up	Down	75%	10%
Green	280.4 within 1%	Down	Up	Down	75%	10%
Blue	422.9 within 1%	Down	Up	Down	75%	10%
Red	609.0 within 1%	Up	Up	Down	75%	10%
Red	676.7 within 1%	Up	Up	Down	75%	0%
Blue	103.4 within 1.5	Up	Down	Down	75%	0%
Green	554.5 within 1.5	Up	Down	Down	75%	0%
Red	657.9 within 1%	Up	Down	Down	75%	0%
Red	158.4 within 1%	Down	Up	Down	75%	0%
Green	311.5 within 1%	Down	Up	Down	75%	0%
Blue	469.9 within 1%	Down	Up	Down	75%	0%
Blue	137.8 within 1.5	Up	Down	Down	100%	0%
Green	739.3 within 1%	Up	Down	Down	100%	0%
Red	877.2 within 1%	Up	Down	Down	100%	0%
Red	902.3 within 1%	Up	Up	Down	100%	0%
Red	812.0 within 1%	Up	Up	Down	100%	10%
Red	190.1 within 1%	Down	Up	Down	100%	10%
Green	372.8 within 1%	Down	Up	Down	100%	10%
Blue	563.9 within 1%	Down	Up	Down	100%	10%
Red	834.6 within 1%	Up	Up	Down	100%	7.5%
Blue	127.5 within 1.5	Up	Down	Down	100%	7.5%
Blue	579.6 within 1%	Down	Up	Down	100%	7.5%

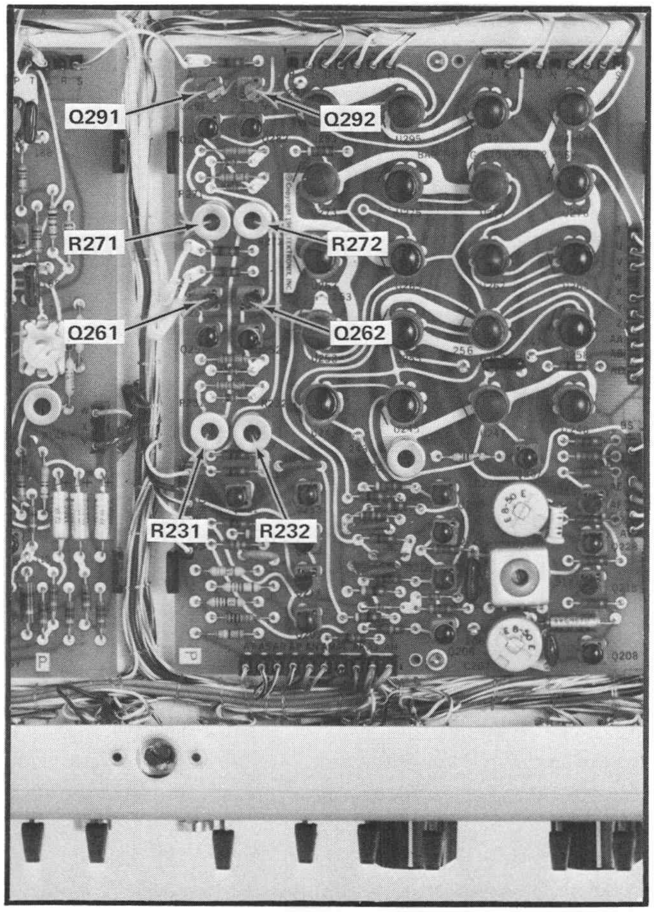


Fig. 6-12. Bar Timing board transistor and adjustment locations.

i. Replace Q261 and remove Q291 then repeat the procedure using 77.8 mV, and adjust R231.

j. Replace Q291.

10. Check —I and Q Chrominance Amplitudes

a. Observing the test oscilloscope display, rotate the V1 and V2 Volts controls until the —I and Q chrominance envelopes just meet.

b. CHECK—Amplitude of —I and Q should range between 282.8 mV and 288.6 mV, 285.7 mV ±1%.

11. Check/Adjust Burst Amplitude

a. Observing the test oscilloscope display, rotate the V1 and V2 Volts controls until the burst envelope peaks just meet.

b. CHECK—Amplitude should equal 285.7 mV within 1%.

c. Set the V1 and V2 Volts controls for 142.85 mV each, then ADJUST—R414 (see Fig. 6-10) until the burst envelopes just meet.

d. Disconnect all test equipment.

STAIRCASE

1. Setup

a. Set the 146 VIDEO, 180° SUBCARRIER, and STEPS switches down, and the remaining switches to the STANDARD SIGNAL position. Set the APL/IRE LEVEL switch to 100.

b. Set the test oscilloscope for a sweep rate of 10 μs with negative external triggering.

c. Set the Type 1A5 Volts/Cm switch to 10 mV, the A and B Input coupling switches to DC, and the Display switch to A-B position.

d. Set the 067-0596-00 Calibration Fixture V1 Range switch to 0 and the V2 Range switch to +1.1 V position.

2. Check/Adjust 100 IRE Level

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input connector. Connect a 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector. Connect a 75 Ω coaxial cable from the 067-0596-00 Chopped Output connector to the Type 1A5 B Input connector.

b. Observing the test oscilloscope display, rotate the V2 Volts control until the 100 IRE level of the lower display just aligns with the blanking level of the upper display.

c. CHECK—Amplitude should equal 714.3 mV within 1%.

d. Set the V2 Volts control for 714.3 mV then ADJUST—R499, (see Fig. 6-10) to align the 100 IRE level with the blanking level.

3. Check/Adjust Sync Amplitude

a. Set the 067-0596-00 Calibration Fixture V2 Range switch to —1.1 V. While observing the test oscilloscope display, rotate the V2 Volts control until the sync tip of the

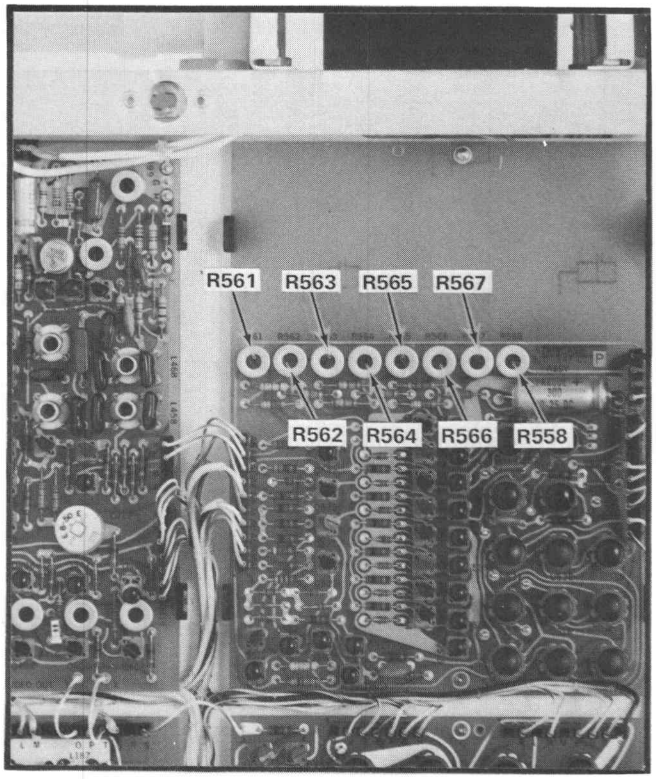


Fig. 6-13. Staircase board adjustment locations.

upper display just aligns with the blanking level of the lower display.

b. CHECK—Sync amplitude should equal 285.7 mV within 1%.

c. Set the V2 Volts control for 285.7 mV then ADJUST—R567 (see Fig. 6-13) for a sync amplitude of 285.7 mV.

4. Check/Adjust Luminance DC Level

a. Set the Type 1A5 Display switch to A-Vc and the A Coupling switch to GND position. Establish 0 V reference level by vertically centering the trace on the CRT with the Position Control. Set the coupling switch to DC position.

b. CHECK—Blanking level of display should equal 0 V within 50 mV.

c. ADJUST—R478 (see Fig. 6-10) so the blanking level is 0 V.

5. Check APL/IRE Level Switch

a. Set the 146 APL/IRE LEVEL switch to 0 position, the V1 and V2 Volts controls to 0 volts and the Type 1A5 Volts/Cm switch to 10 mV, Display switch to A-B, and the A and B Input Coupling switches to DC.

b. While observing the test oscilloscope display, position the blanking level of the display to the CRT center with the Position Control.

c. Set the V2 Range switch to −1.1 V, and the V2 Volts control for 71.4 mV.

d. Set the 146 APL/IRE LEVEL switch to 10, then rotate the Type 1A5 Position control fully counterclockwise.

e. Observing the test oscilloscope display, rotate the V2 Volts control to align the 10 level with the blanking level.

f. CHECK—Amplitude should equal 71.4 mV within 2%.

g. Set the V2 Range switch to 0, the V1 Range switch to +1.1 V position, then center the Type 1A5 Position control.

h. Observing the test oscilloscope display, rotate the V1 Volts control to align the 10 level with the blanking level.

i. Set the 146 APL/IRE LEVEL switch to 20, then turn the Type 1A5 Position control fully counterclockwise.

j. Set the V1 Range switch to −1.1 V. Rotate the V1 Volts control until the blanking level and 20 level are aligned.

k. CHECK—Amplitude should equal 71.4 mV within 2%.

l. Using Table 6-2 as a guide, check remaining APL/IRE settings as listed.

TABLE 6-2

APL/IRE LEVEL	Type 1A5 Position	067-0596-00				
		V1 RANGE	V1 VOLTS	V2 RANGE	V2 VOLTS	Repeat
20	Midrange	+1.1 V	≈142.8	0	≈71.4 mV	h
30	CCW	+1.1 V	≈142.8	−1.1 V	≈71.4 mV	j and k
30	Midrange	+1.1 V	≈214.2	0	≈71.4 mV	h
40	CCW	+1.1 V	≈214.2	−1.1 V	≈71.4 mV	j and k
40	Midrange	+1.1 V	≈285.6	0	≈71.4 mV	h
50	CCW	+1.1 V	≈285.6	−1.1 V	≈71.4 mV	j and k
50	Midrange	+1.1 V	≈357.0	0	≈71.4 mV	h
60	CCW	+1.1 V	≈357.0	−1.1 V	≈71.4 mV	j and k
60	Midrange	+1.1 V	≈428.4	0	≈71.4 mV	h
70	CCW	+1.1 V	≈428.4	−1.1 V	≈71.4 mV	j and k
70	Midrange	+1.1 V	≈499.8	0	≈71.4 mV	h
80	CCW	+1.1 V	≈499.8	−1.1 V	≈71.4 mV	j and k
80	Midrange	+1.1 V	≈571.2	0	≈71.4 mV	h
90	CCW	+1.1 V	≈571.2	−1.1 V	≈71.4 mV	j and k
100	Midrange	+1.1 V	≈642.6	0	≈71.4 mV	h
100	CCW	+1.1 V	≈642.6	−1.1 V	≈71.4 mV	j and k

6. Check/Adjust Staircase Levels

a. Set the 146 APL/IRE LEVEL switch to 50% and the STEPS switch to 10, then set the Calibration Fixture V1 Range switch to 0 and the V2 Range switch to +1.1 V positions.

b. Observing the test oscilloscope display, adjust the Type 1A5 Position control to position the blanking level of the upper display to the CRT center. (This will be used as the reference to check or adjust the staircase levels.)

c. Using Table 6-3 and Fig. 6-13 as a guide, CHECK or ADJUST the staircase levels for 71.4 mV, ±3% between the 10 step levels.

TABLE 6-3

10 STEP			5 STEP	
Step	V2 Volts	Adjust	Step	V2 Volts
1	71.4 mV	R562	1	142.8 mV
2	142.8 mV	R568	2	285.6 mV
3	214.2 mV	R563	3	428.4 mV
4	285.6 mV	————	4	571.3 mV
5	357.0 mV	R564	5	714.3 mV
6	428.4 mV	————	———— Indicates CHECK Only	
7	499.8 mV	R565		
8	571.2 mV	————		
9	642.6 mV	R566		
10	714 mV	————		

d. Set the 146 STEPS switch to position 5, then using Table 6-3 CHECK the 5 step levels for 142.8 mV, ±1% between steps.

7. Check/Adjust Staircase Transient Response

a. Set the Type 1A5 Display switch to A-Vc position, the Volts/Cm switch to 20 mV and rotate the Variable (Volts/Cm) control for a display amplitude of 5 cm between the blanking level and the 1st step.

b. CHECK—Aberrations on the corner of the first step should not exceed 2% of 5 cm reference.

c. ADJUST—L458 and L468, (see Fig. 6-14) for optimum square corners on the display with aberrations of 2% or less.

8. Check/Adjust Staircase Chrominance

a. Set the 146 STEPS switch to OFF and the 180° SUBCARRIER switch up. Set the Type 1A5 Volts/Cm switch to 10 mV, Display switch to A-B, and the Variable (Volts/Cm) control to Cal position.

b. While observing the test oscilloscope display, rotate the V2 Volts control until the peaks of the 180° subcarrier envelopes just meet.

c. CHECK—Amplitude should equal 143 mV within 3%.

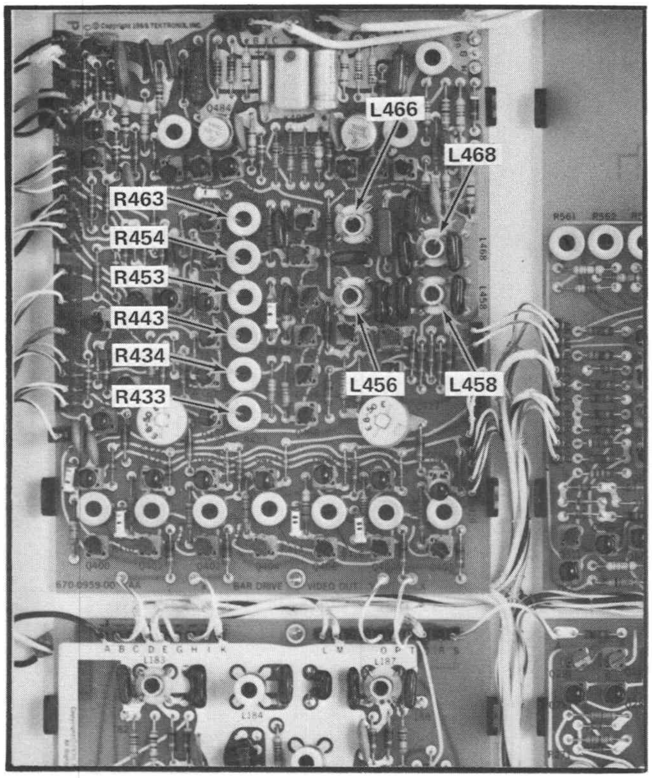


Fig. 6-14. Bar Drive and Video Out board adjustment locations.

d. Set the V2 Volts control for 143 mV then ADJUST—R561 (see Fig. 6-13) until the peaks of the envelopes just meet.

9. Check Staircase Chrominance Duration

a. Set the Type 1A5 Display switch to A-Vc position.

b. CHECK—Duration of Chrominance should equal 40 μs within 5% (2 μs). (Measure at 50% amplitude points on either the positive or negative excursion.)

10. Check Staircase Timing

a. Set the 146 180° SUBCARRIER switch down, STEPS switch to 5, and the APL/IRE LEVEL switch to 50% position. Set the Type 1A5 Volts/Cm to .2 V position. Set the test oscilloscope for B intensified mode with an A sweep rate of 2 μs/Div and a B sweep rate of 10 μs/Div. Use negative slope for triggering the display.

b. Observing the test oscilloscope display, rotate the Delay-Time Multiplier to intensify the blanking level portion of the display.

c. Set the test oscilloscope for A Delayed mode.

d. CHECK—Time from end of blanking to start of first step should equal 13.2 μs, ±5%.

e. Rotate the Delay Time Multiplier control to measure the White level duration.

f. CHECK—White level duration should equal 13.2 μs, ±5%.

g. Using the Delay Time Multiplier control, measure the duration of any step function.

h. CHECK—Step duration should equal 6.6 μs within 5%.

i. Set the 146 STEPS switch to 10. Set the test oscilloscope for an A sweep rate of 1 μs/Div then repeat the procedure using 9.9 μs ±5%, for white level and 3.3 μs ±5%, for steps.

11. Check APL

a. Set the test oscilloscope display for B mode at a sweep rate of .2 ms/div, Trigger the display internally.

b. CHECK—10 Step staircase signal on each active video line.

c. Set the 146 APL/IRE LEVEL switch to 0 position.

d. CHECK—10 step staircase signal every fifth active video line.

e. While observing the test oscilloscope display, rotate the APL/IRE LEVEL switch from 0 through 100.

f. CHECK—Variable APL should be observed on four of five active video lines.

g. Disconnect all test equipment.

LUMINANCE BAR

1. Setup

a. Set the 146 R—Y and B—Y switches down, the FIELD DISPLAY switch to FULL FIELD COLOR BARS, the APL/IRE LEVEL switch to 50% and the remaining switches to the STANDARD SIGNAL position.

b. Set the test oscilloscope for a sweep rate of 10 µs/div. Use external triggering on negative slope.

c. Set the Type 1A5 Volts/Cm switch to 10 mV position, Display switch to A-B, and the A and B Input coupling switches to DC position.

d. Set the 067-0596-00 Calibration Fixture V1 Range switch to 0 and V2 Range switch to +1.1 V.

2. Check/Adjust Black Level

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable with a 75 Ω termination to the Type 1A5 A Input connector. Connect a 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector. From the 067-0596-00 Chopped Output, connect a 75 Ω coaxial cable to the Type 1A5 B Input.

b. Observing the test oscilloscope, rotate the V2 Volts control to align the black level (setup) with the blanking level.

c. CHECK—Black level (Setup) should equal 53.6 mV within 1.5 mV.

d. Set the V2 Volts control for 53.6 mV then ADJUST—R433 (see Fig. 6-14) for a black level amplitude of 53.6 mV.

3. Check/Adjust Luminance Levels

a. Using Table 6-4 and the procedure described in Step 2, CHECK or ADJUST the listed levels to within 1% or 1.5 mV of the amplitude specified, whichever is greater.

TABLE 6-4

Level	Amplitude	Check/Adjust
Blue	108.1 mV	R463
Red	202.0 mV	R453
Magenta	256.7 mV	Check
Green	345.9 mV	R454
Cyan	400.4 mV	Check
Yellow	494.6 mV	Check
White	549.1 mV	Check
White (Set WHITE REF to 100 IRE)	714.3 mV	R443
White (Set WHITE REF and FIELD DISPLAY switches up.)	714.3 mV	R434

4. Check Luminance Levels

a. Set the 146 FIELD DISPLAY switch to FULL FIELD COLOR BARS position.

b. Using Table 6-5 and the procedure described in Step 2 as a guide, CHECK the levels listed. If any are out of tolerance, repeat Step 3.

TABLE 6-5

Level	Switch Settings		
	146		067-0596-00
	AMPL	SETUP	V2 Volts Limit
White	75%	10%	553.6 to 559.1 mV
White	75%	0%	535.6 to 541.1 mV
White	100%	0%	713.8 to 721.1 mV
White	100%	10%	713.8 to 721.1 mV
White	100%	7.5%	713.8 to 721.1 mV

5. Check Luminance Aberrations

a. Set the Type 1A5 Display switch to A-Vc and the Polarity switch to + position.

b. Observing the test oscilloscope display, rotate the Vc Amplitude control to position the luminance levels into view.

c. CHECK—Aberrations on any level should not exceed 40 mV.

6. Adjust White Transient Response

a. Set the Type 1A5 Polarity switch to 0. Position the test oscilloscope display on screen, then observing the display, set the Volts/Cm and Variable (Volts/Cm) controls to obtain a display amplitude of 5 cm between blanking and the white level.

b. ADJUST—L456 and L466 (see Fig. 6-14) for the optimum square corner on leading edge of display.

7. Check/Adjust Full Field Bar Width

a. Set the Type 1A5 Volts/Cm switch to .2 V and the Variable (Volts/Cm) control to Cal position.

b. Observing the test oscilloscope display, rotate the Horizontal Position control to position the black level on the CRT.

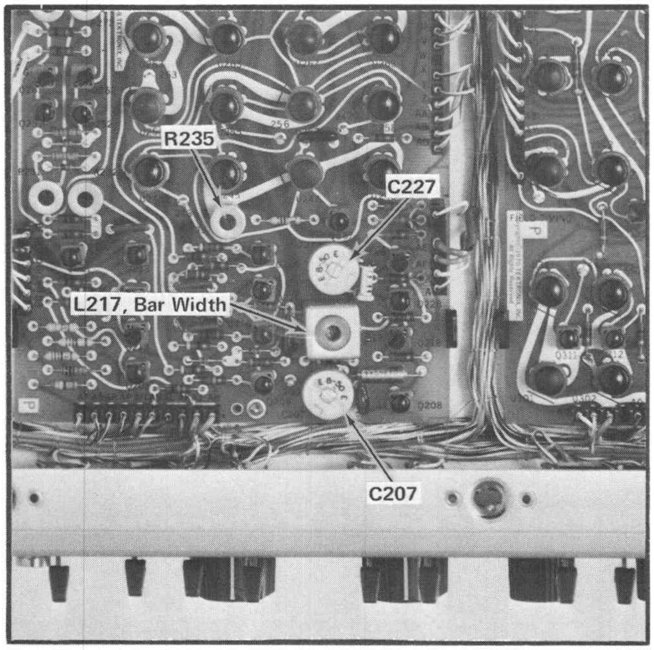


Fig. 6-15. Bar Timing board adjustment locations.

c. CHECK—Black Bar width (setup) should equal 6.6 µs within 0.3 µs. (Measure at 10% from quiescent.)

d. ADJUST—L217 (see Fig. 6-15) for 6.6 µs.

e. INTERACTION—Step 8 must be checked after this adjustment.

8. Check/Adjust Luminance to Chrominance Delay

a. Set the test oscillosope for B Intensified mode with an A sweep rate of 1 µs/Div, and a B sweep rate of 10 µs/Div (Sweep Magnifier X1).

b. Set the 146, R—Y, B—Y, and AMPL switches up. Set the Y switch down.

c. Observing the test oscilloscope display, rotate the Delay Time Multiplier control to intensify the green-magenta transition, then set the test oscilloscope display for A Dly'd mode.

d. Center the green magenta transition on the CRT with the Horizontal and Vertical Position controls. (Press the 146 COLOR LOCK UNLOCK switch to free-run the display while centering.)

NOTE

Do not move the Horizontal Position control until after the completion of this step.

e. Set the 146 R—Y and B—Y switches down, the Y switch up.

f. CHECK—50% point on luminance transition should be within 20 ns of the reference established in Step d.

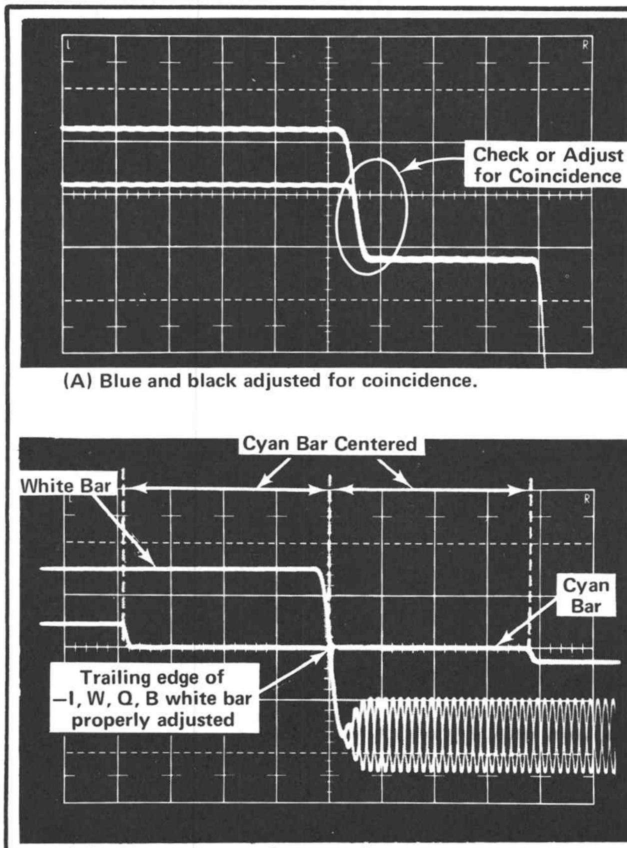
g. ADJUST—R235 (see Fig. 6-15) to position the 50% point of the green-magenta to the reference established in step d.

h. INTERACTION—Full field bar width (step 6) must be rechecked.

9. Check/Adjust EIA Color Bar Width

a. Set the 146 R—Y and B—Y switches down, the Y switch up, and the FIELD DISPLAY switch to EIA COLOR BARS position. Set the test oscilloscope for B mode with a sweep rate of 10 µs/Div.

b. CHECK—Trailing edge of FULL FIELD blue bar should coincide with trailing edge of —I, W, Q, B black bar; see Fig. 6-16A.



(A) Blue and black adjusted for coincidence.

(B) White bar centered on cyan bar.

Fig. 6-16. Typical test oscilloscope displays to check or adjust EIA COLOR BAR timing.

c. ADJUST—C207 (see Fig. 6-15) for coincidence of blue and black level trailing edges.

d. CHECK—Trailing edge of —I, W, Q, B white pulse should be centered on Full Field cyan bar, see Fig. 6-16B.

e. ADJUST—C227 to center the trailing edge of the white pulse on the cyan bar.

f. Disconnect all test equipment.

HORIZONTAL TIMING

1. Setup

a. Set the R—Y, B—Y, AMPL, and STEPS switches down, FIELD DISPLAY switch to FULL FIELD COLOR BARS, the SETUP switch to 10% and the remaining switches to STANDARD SIGNAL position.

b. Set the test oscilloscope for A Dly'd mode with an A sweep rate of 2 µs/Div, B sweep rate of 10 µs/Div. Trigger externally on negative slope.

c. Set the Type 1A5 Display switch to A-Vc, Volts/Cm switch to .2 V, and the A Input coupling switch to DC position.

2. Check/Adjust Horizontal Timing

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable from a 75 Ω termination to the Type 1A5 A Input connector. Connect a second 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector.

b. Observing the test oscilloscope display, rotate the Delay Time Multiplier to position the blanking interval into view. (Fig. 6-17 illustrates a typical display.)

c. Using Fig. 6-17 as a guide, CHECK or ADJUST the horizontal timing as listed in Table 6-6.

d. Disconnect all test equipment.

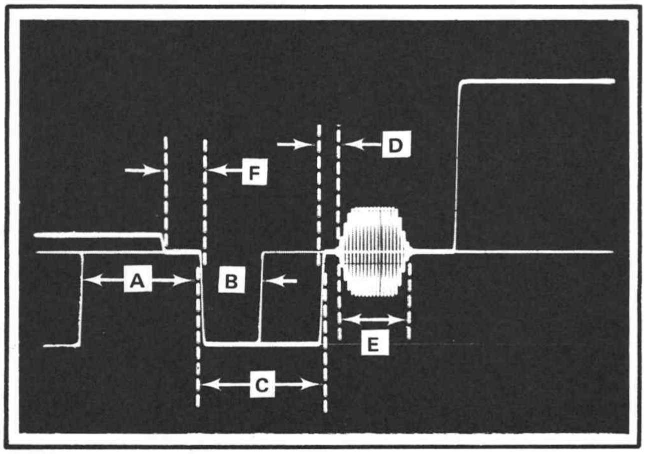


Fig. 6-17. Typical test oscilloscope display of the blanking interval used to check timing.

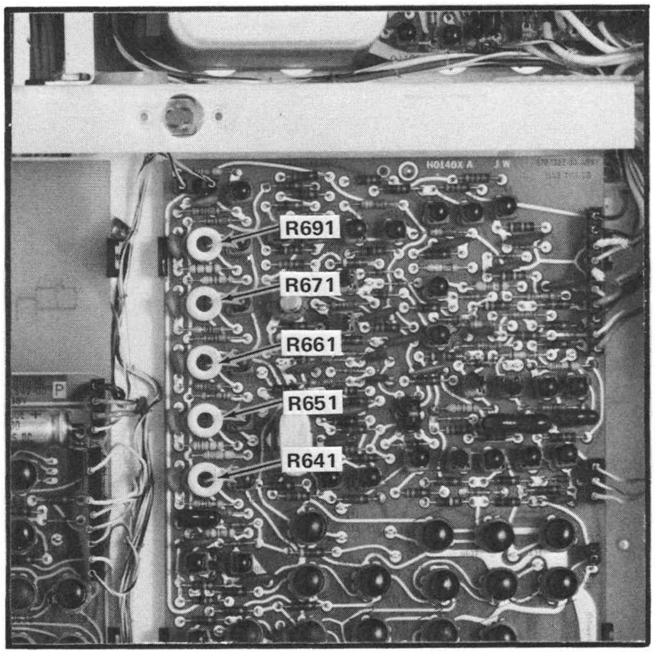


Fig. 6-18. Line Timing board adjustment locations.

TABLE 6-6

Area Affected (See Fig. 6-17)	Component Duration	Timing		Adjustment (See Fig. 6-18)
		Set For:	Check For:	
A	Interval Between Field Sync Pulses	4.5 µs	4.3 to 4.7 µs	R691
B	Equalizer Pulse	2.35 µs	2.3 to 2.4 µs	R671
C	Sync Pulse	4.71 µs	4.66 to 4.76 µs	R661
D	Breezeway	750 ns	700 to 800 ns	R651
E	Burst	2.31 µs	2.2 to 2.4 µs	R641
F	Front Porch	1.54 µs	1.49 to 1.59 µs	————

VITS

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL position, the APL/IRE LEVEL switch to 50%, and the LINE switch to 15.

b. Set the Type 1A5 Volts/Cm switch to .2 V and the Display switch to A-Vc position.

c. Set the test oscilloscope display for B Intensified mode with an A sweep rate of .2 ms/Div and a B sweep rate of 5 ms/Div. Use external triggering with negative slope.

2. Check VITS

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and a 75 Ω termination to the Type 1A5 A Input connector. Connect another 75 Ω coaxial cable from the rear-panel VERT DRIVE connector to the test oscilloscope Trigger Input connector.

b. Observing the test oscilloscope display, rotate the Delay Time Multiplier control to intensify one of the vertical blanking intervals.

c. Set the test oscilloscope Horizontal Display for A Dly'd mode.

d. Determine the field being displayed by referring to Fig. 1-3 in the Specification Section.

e. Observing the test oscilloscope display, switch the VITS LINE switch through its range.

f. CHECK—VITS must be on the corresponding line as indicated by the VITS LINE switch position.

3. Check VITS SIGNAL Switch

a. Observing the test oscilloscope display, switch the VITS SIGNAL switch to OFF then to COLOR BARS position.

b. CHECK—Test oscilloscope display of VITS should correspond to the setting of the VITS SIGNAL switch.

4. Check VITS FIELD Switch

a. While observing the test oscilloscope display, switch the VITS FIELD switch to BOTH then 2 position.

b. CHECK—Display of VITS should appear on the field corresponding to the setting of the VITS FIELD switch.

c. Disconnect all test equipment.

CONVERGENCE PATTERN

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL position.

b. Set the Type 1A5 Volts/Cm selector to 10 mV position, the Display switch to A—B, and both Input Coupling switches to the DC position.

c. Set the test oscilloscope display for B mode with a sweep rate of 10 µs/Div. Trigger externally.

d. Set the 067-0596-00 Calibration Fixture, V1 Range switch to 0 V and the V2 Range switch to +1.1 V.

2. Adjust Peak Amplitude

a. From the 146 CONVERGENCE PATTERN connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input connector. Connect a second 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector.

b. Connect a 75 Ω coaxial cable from the 067-0596-00 Calibration Fixture Chopped Output connector to the Type 1A5 B Input connector.

c. While observing the test oscilloscope display, rotate the V2 Volts Control until the peak of the bottom display just aligns with the blanking level of the upper display.

d. CHECK—Amplitude should equal 549.1 mV within 5%.

e. Set the V2 Volts control for 549.1 mV, then ADJUST R739 (see Fig. 6-19) to align the peak of the lower display with the blanking level of the upper display.

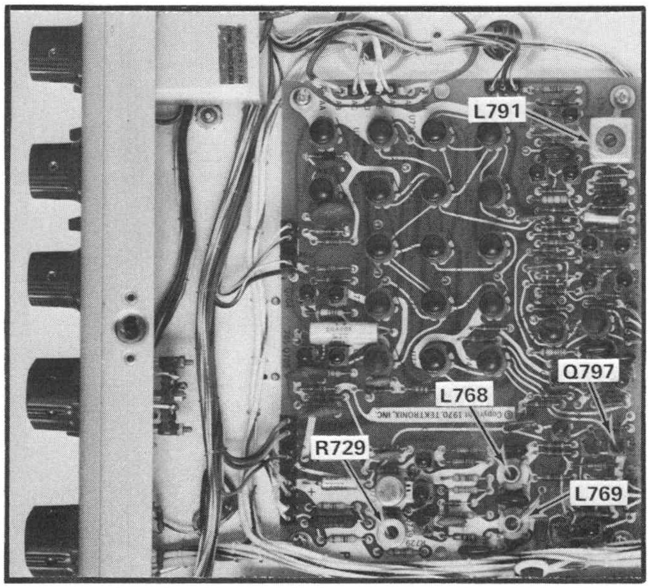


Fig. 6-19. Cross Hatch board adjustment locations.

3. Check Setup Amplitude

a. While observing the test oscilloscope display, rotate the V2 Volts control to align the setup level of the lower display with the blanking level of the upper display.

b. CHECK—Setup level should equal 53.6 mV, ±5%.

4. Check Sync Amplitude

a. Set the V2 Range switch to −1.1 V position.

b. While observing the test oscilloscope display, rotate the V2 Volts control to align the sync tip level of the upper display with the blanking level of the lower display.

c. CHECK—Sync amplitude should equal −286 mV ±5%.

5. Check DC Level

a. Set the Type 1A5 Volts/Cm to .1 V, the Display switch to A-Vc position and center the blanking level of the display to the CRT vertical center with the Position control.

b. Set the Type 1A5 A and B Input coupling switch to GND position.

c. CHECK—CRT trace should be within 100 mV of the vertical center.

6. Check/Adjust Vertical Pulses

a. Set the Type 1A5 Volts/Cm switch to .2 V and the A Input coupling switch to DC position. Set the 146 CONVERGENCE PATTERN CROSSHATCH switch to VERT and rotate the HORIZ POSITION control fully clockwise.

b. CHECK—There should be 17 pulses, with the first and last pulse an equal distance from the leading and trailing edges of setup display.

c. ADJUST—L791 (see Fig. 6-19) for 17 pulses as described in step b.

d. Rotate the HORIZ POSITION control fully counterclockwise.

e. CHECK—There should be 16 to 17 pulses on the display.

7. Adjust Convergence Transient Response

a. Set the 146 CROSSHATCH switch to HORIZ position. Set the Type 1A5 Volts/Cm and Variable (Volts/Cm) controls for a display amplitude of 5 cm between the blanking level and the peak of the horizontal pulse.

b. ADJUST—L768 and L769 (see Fig. 6-19) for optimum square corner on the display.

8. Check Crosshatch Pulse Duration

a. Set the 146 HORIZ POSITION control fully clockwise and the CROSSHATCH switch to VERT position. Set the test oscilloscope for a B sweep rate of 2 μs/Div. Sweep Magnifier at X10 position.

b. CHECK—Pulse duration should equal 225 ns within 15%, as measured between the 50% points between setup and the pulse peak.

9. Check Dot Pulse Duration

a. Set the 146 DISPLAY switch to DOTS position.

b. CHECK—Dot pulse duration should equal 350 ns within 15% as measured at the 50% points between setup and the pulse peak.

10. Check HORIZ POSITION Range

a. Set the 146 CROSSHATCH switch to VERT position, DISPLAY switch to CROSSHATCH, and rotate the HORIZ POSITION control fully counterclockwise. Set the test oscilloscope Time/Cm switch to 10 μs. Sweep Magnifier to X10 position.

b. While observing the test oscilloscope display, rotate the test oscilloscope, Horizontal Position control to center the peak of a pulse at CRT center.

c. Observing the test oscilloscope display, rotate the 146 HORIZ POSITION control fully clockwise.

d. CHECK—Pulse should have moved at least 3.2 μs from the reference established in Step b.

11. Check VERT POSITION Range

a. Disconnect the 75 Ω coaxial cable from the 146 rear-panel HORIZ DRIVE connector and reconnect it to the VERT DRIVE connector.

b. Set the test oscilloscope for a sweep rate of 2 ms/Div, Sweep Magnifier off. Set the 146 CROSSHATCH switch to HORIZ and rotate the VERT POSITION control fully counterclockwise.

c. Observing the test oscilloscope display, rotate the test oscilloscope Horizontal Position control to position a pulse to start at the CRT graticule center.

d. While observing the test oscilloscope display, rotate the VERT POSITION control fully clockwise.

e. CHECK—Pulse should have moved at least 1.1 ms.

f. Disconnect all test equipment.

GEN LOCK

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL position.

b. Set the test oscilloscope display for B mode with a sweep rate of 10 μs/Div with external triggering.

c. Set the Type 1A5 Display switch to A-Vc position, Volts/Cm switch to .2 V and the A Input coupling switch to DC position.

2. Check Loss of Burst Indicator

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input connector. Connect a second 75 Ω coaxial cable from the rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector. Connect 75 Ω end-line terminations to both the rear-panel GEN LOCK and SUBCARRIER input connectors. (Leave one Loop-Thru on each input unterminated.)

b. While observing both the test oscilloscope display and the 146 front-panel indicator lights, switch the SYNCHRONIZATION REF to EXT STD position.

c. CHECK—Front-panel AUTO INT SUBCARRIER light should be on and display should consist of composite video without chroma. (See Options, Section 2 for exceptions.)

d. From an external video source (Type 140 or 146), apply a 2 V peak to peak subcarrier signal via a 75 Ω coaxial cable to the 146 rear-panel, unused SUBCARRIER Input connector.

e. CHECK—Front-panel AUTO INT SUBCARRIER light should be off and display should consist of composite video.

3. Check Loss Of Sync Indicator

a. Set the 146 REF switch to COLOR GEN LOCK position.

b. CHECK—AUTO INT SYNC and SUBCARRIER lights should light and display should consist of sync only. (See Options, Section 2 for exceptions.)

c. From the external signal source (Type 140 or 146), apply a 1 V peak to peak composite video signal via a 75 Ω coaxial cable to the 146 rear-panel (unused) GEN-LOCK Input connector.

d. CHECK—Both the AUTO INT SYNC and SUBCARRIER lights are extinguished and display should consist of composite video.

4. Adjust Gen Lock Phasing

a. Disconnect the external signals to the GEN LOCK and SUBCARRIER Input connectors. Disconnect the two 75 Ω end-line terminations on the GEN LOCK and SUBCARRIER input connectors.

b. From the external signal source, apply a 2 V peak to peak subcarrier signal, via a 75 Ω coaxial cable and 10X 75 Ω attenuator, to the Vectorscope CH A (J1) Input con-

nector. (Do not terminate the other CH A (J2) Input connector.) Connect a 75 Ω line termination to the Vectorscope Ext CW Φ Ref connector. Connect the external subcarrier signal via a 75 Ω coaxial cable to the other Ext CW Φ Ref connector. Set the Vectorscope for a Vector display with external phasing.

c. Observing the Vectorscope display, rotate the Channel A Phase control to align the vector at 180°. Do not move the Channel A Phase control from this setting.

d. Disconnect and remove the 75 Ω cable and 10X attenuator between the signal generator and the vectorscope CH A (J1) input connector. Terminate the CH A (J2) input connector with a 75 Ω end-line termination. Now, using the 75 Ω cable that was removed, apply external composite video signal to the Vectorscope CH A (J1) input connector.

e. While observing the Vectorscope display, rotate the external video source Subcarrier Phase control to align the burst vector at 180°. Do not move the Phase control from this setting.

f. Disconnect the 75 Ω coaxial cable from the Vectorscope CH A (J1) connector and apply the composite video signal to the 146 rear-panel GEN LOCK Input connector. Terminate the other 146 GEN LOCK input connector with the 75 Ω end-line termination from the Vectorscope CH A (J2) input connector.

g. From the 146 SUBCARRIER connector, connect a 75 Ω coaxial cable and 10X 75 Ω termination to the Vectorscope CH A (J1) Input connector. Do not terminate the other CH A (J2) Input connector.

h. CHECK—Vector should be on the Q axis (45°).

i. ADJUST—L5190 (see Fig. 6-20) to align the vector at 45°.

j. Disconnect all test equipment between the external signal source, vectorscope, and the 146.

5. Check CW Operation

a. From the external signal source, apply composite sync signal via a 75 Ω coaxial cable and a 75 Ω termination to the 146 rear-panel GEN LOCK Input connector. Apply a 2 volt peak to peak subcarrier signal via a 75 Ω coaxial cable and 10X 75 Ω attenuator to the other GEN LOCK Input connector.

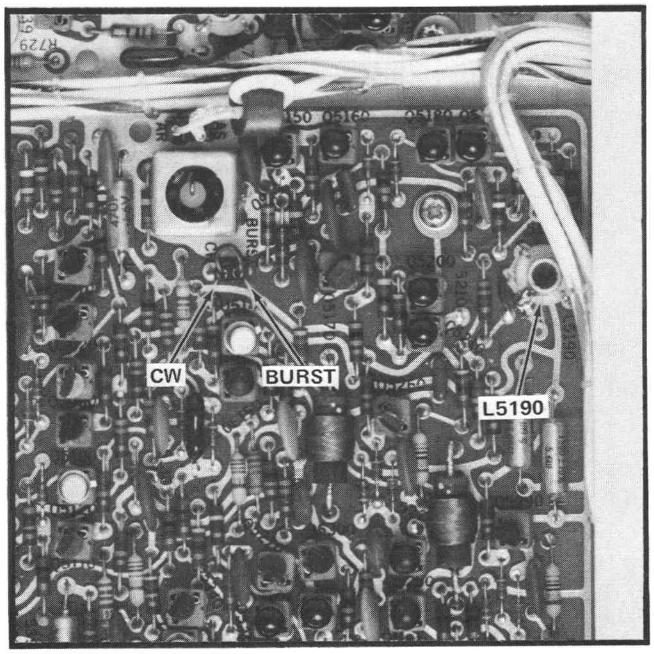


Fig. 6-20. Gen Lock board adjustment location; location of BURST-CW jumper wire.

b. CHECK—Test oscilloscope display should consist of composite video without chroma and the 146 front-panel AUTO INT SUBCARRIER light should be on.

c. Remove the BURST-CW jumper wire (see Fig. 6-20).

d. CHECK—Test oscilloscope display should consist of composite video, while the 146 front-panel AUTO INT SUBCARRIER light should be off.

e. Replace the jumper wire (removed in Step c) in the BURST position.

f. Disconnect all test equipment between the 146 and the external signal source.

6. Adjust Line Sync Gen Lock Delay

a. From an external signal source (such as Type 140 or 146) connect a 1 volt peak to peak composite video signal to the 146 rear-panel GEN LOCK Input connector. From the 146 unused Input GEN LOCK connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 B Input connector.

b. Set the test oscilloscope sweep rate for 1 μs/Div.

Ⓐ

c. While observing the test oscilloscope display, adjust the Type 1A5 Variable (Volts/Cm) control and Volts/Cm selector to obtain a display amplitude of 5 cm between the blanking level and the sync tip level.

d. While observing the test oscilloscope display, rotate the Horizontal Position control to align the 10% amplitude point on the leading edge of sync to a major graticule line. Do not move the Horizontal Position control for the remainder of this step.

e. Set the Type 1A5 Display switch to Vc-B and the B Input coupling switch to DC position, then position the display to view the sync pulse.

f. While observing the test oscilloscope display, rotate the 146 front-panel LINE SYNC GEN LOCK DELAY control fully counterclockwise.

g. CHECK—Leading edge of sync pulse should be adjustable at least 1 µs from the referenced established in Step d.

h. While observing the test oscilloscope display, rotate the LINE SYNC GEN LOCK DELAY control fully clockwise.

i. CHECK—Leading edge should be adjustable at least 3 µs from the reference established in Step d.

j. ADJUST—With the LINE SYNC GEN LOCK DELAY control, position the 10% amplitude point on the leading edge of sync to the referenced established in step d.

k. Disconnect all test equipment.

OTHER OUTPUTS

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL position.

b. Set the Type 1A5 Display switch to A-Vc, Volts/Cm switch to 1 V, and the A Input Coupling switch to DC position.

c. Set the test oscilloscope for internal triggering.

2. Check/Adjust Output Amplifiers

a. Using Fig. 6-21 as a guide, CHECK and ADJUST the 146 outputs as listed in Table 6-7. (Adjust for best square corners on the display.)

NOTE

Use a 75 Ω coaxial cable and 75 Ω termination between Type 1A5 and 146.

TABLE 6-7

146 Output	Recommended Time/Cm Settings		CHECK FOR			ADJUST (See Fig. 6-21)
	Check Amplitude	Adjust	Amplitude	Timing		
BURST FLAG	10 µs	.5 µs	4 V P-P within 0.2 V	2.3 µs at −4 V within 5%		L904 & L905
				61.2 µs at 0 V		
HORIZ DRIVE	10 µs	1 µs	4 V P-P within 0.2 V	6.35 µs at −4 V within 5%		L924 & L925
				57 µs at 0 V		
VERT DRIVE	2 ms	5 ms	4 V P-P within 5%	666.7 µs at −7 V		L944 & L945
				8 ms at 0 V		
COMP SYNC	10 µs	1 µs	4 V P-P within 0.2 V	4.7 µs at −4 V within 0.5 µs		L964 & L965
				58.8 µs at 0 V		
COMP BLANKING	10 µs	2 µs	4 V P-P within 5%	11.1 µs at −4 V	LINE	L984 & L985
				52.4 µs at 0 V	RATE	
				1.33 ms at −4 V	FIELD	
				15.33 ms at 0 V	RATE	

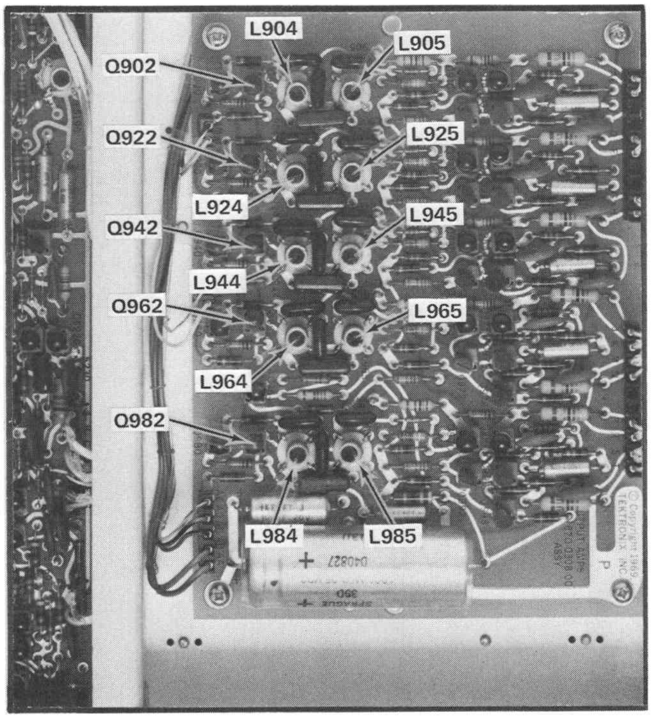


Fig. 6-21. Output Amps board transistor and adjustment locations.

RETURN LOSS

1. Setup

a. Set the 146 switches to the STANDARD SIGNAL position.

b. Set the Type 1A5 Display switch to A-Vc position, Volts/Cm to .1 V, and the A and B Input coupling switches to AC positions.

c. Set the test oscilloscope for a free running sweep at .1 ms/Div.

2. Check Instrument Return Loss

a. Connect one of two matched 75 Ω terminations to the 015-0149-00 Calibration Fixture Reference coaxial cable, then connect the calibration fixture to the Type 1A5 A and B Input connectors.

b. From the Constant Amplitude Signal Generator (Type 191), apply a 50 kHz sine wave via its 5 ns coaxial cable, BNC Male to GR Adapter, and a 50 Ω to 75 Ω minimum loss attenuator, to the Input connector on the Calibration Fixture.

c. While observing the test oscilloscope display, set the signal generator output for a peak to peak signal amplitude of 500 mV.

d. Set the Type 1A5 Display switch to A-B and the Volts/Cm switch to 1 mV position. Set the signal generator for a frequency of 5 MHz. Connect the other matched 75 Ω termination to the Unknown coaxial cable on the calibration fixture.

e. Check the test oscilloscope for a display amplitude of 1 mV or less.

f. Remove the 75 Ω termination from the Unknown coaxial cable. Set the Type 1A5 Volts/Cm switch to 10 mV position.

g. Remove Q902, Q922, Q962, and Q982. (See Fig. 6-21 for transistor locations.)

h. Connect the Unknown coaxial cable of the Calibration Fixture to the 146 BURST FLAG connector.

i. CHECK—Display amplitude should not exceed 15 mV peak to peak (30 dB).

j. Repeat the procedure (steps h and i) for the HORIZ DRIVE, VERT DRIVE, COMP SYNC, and COMP BLANKING output connectors.

k. Replace the transistors removed in step g and reconnect the matched 75 Ω termination, disconnected in step f, to the 146 rear-panel GEN LOCK input connector. Connect the Unknown coaxial cable of the Calibration Fixture to the other GEN LOCK Input connector.

l. CHECK—Amplitude should not exceed 15 mV peak to peak (30 dB).

m. Repeat the procedure to check the 146 rear-panel SUBCARRIER Input connector return loss.

n. Remove the 75 Ω matched termination and coaxial cable from the SUBCARRIER Input connectors. Set the signal generator for a 3.58 MHz sine wave output.

o. Using a jumper cable short L1197 (see Fig. 6-22), then connect the Unknown coaxial cable of the Calibration Fixture to the 146 SUBCARRIER connector.

p. CHECK—Amplitude should not exceed 15 mV peak to peak (30 dB).

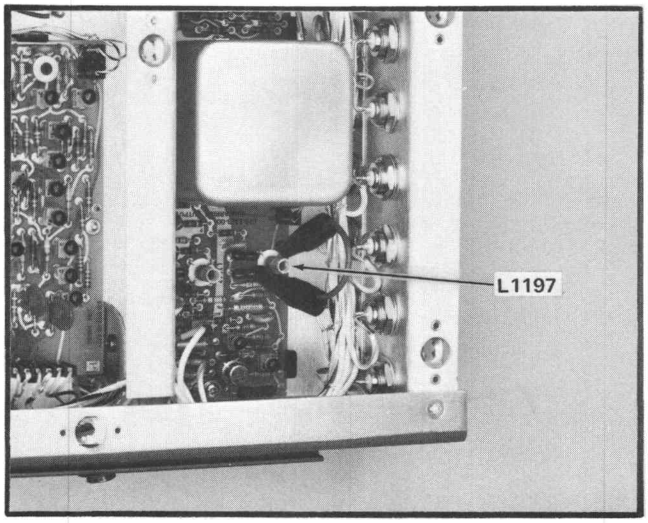


Fig. 6-22. Subcarrier Output board with L1197 shorted.

q. Remove the jumper across L1197 and remove Q797 (Fig. 6-19).

r. Connect the Unknown coaxial cable of the Calibration Fixture to the CONVERGENCE PATTERN connector on the 146 and change the signal generator frequency to 5 MHz.

s. CHECK—Amplitude should not exceed 15 mV peak to peak (30 dB).

t. Replace Q797 and disconnect all test equipment.

ISOLATION

1. Setup

a. Set the 146 Y switch down, SETUP switch to 0%, the FIELD DISPLAY switch to FULL FIELD COLOR BARS and the remaining switches to STANDARD SIGNAL position.

b. Set the Type 1A5 Volts/Cms switch to 10 mV, Display switch to A-B, and the A and B Input coupling switches to DC position.

c. Set the test oscilloscope for a sweep rate of 10 μs/Div with external triggering on the negative slope.

d. Set the 067-0596-00 Calibration Fixture V1 Range switch to −1.1 V and the V2 Range switch to +1.1 V.

2. Check Isolation

a. From the 146 COMP VIDEO connector, connect a 75 Ω coaxial cable and 75 Ω termination to the Type 1A5 A Input connector. Connect a 75 Ω coaxial cable from the 146 rear-panel HORIZ DRIVE connector to the test oscilloscope Trigger Input connector.

b. Connect a 75 Ω coaxial cable from the 067-0596-00 Calibration Fixture Chopped Output connector to the Type 1A5 B Input connector.

c. While observing the test oscilloscope display, rotate the V1 and V2 volts controls until the peaks of the red chrominance envelope just meet.

d. NOTE and RECORD the amplitude.

e. Short the 146 rear-panel COMP VIDEO connector, and repeat the procedure described in steps c and d.

f. CHECK—Isolation should be 40 dB or greater.

NOTE

$$\text{Isolation} = 20 \log \frac{\text{Step C Voltage}}{\text{Step E Voltage}}$$

g. Check the isolation of the COMP SYNC, COMP BLANKING, and the CONVERGENCE PATTERN output connectors, using the same procedure as described for the COMP VIDEO output connectors.

DIFF GAIN AND DIFF PHASE

1. Setup

a. Set the 146 VIDEO switch down, the APL/IRE LEVEL switch to 0 and the remaining switches to STANDARD SIGNAL position.

b. Set the Vectorscope for a vector display with external sync and Φ Ref.

2. Check Diff Gain

a. From the 146 rear-panel COMP VIDEO connector, connect a 75 Ω coaxial cable and 011-0100-01 Voltage Step Up Termination to the Vectorscope CH A (J1) Input connector. (Do not terminate the other CH A (J2) Input connector on the Vectorscope.)

b. Connect a 75 Ω coaxial cable from the 146 rear-panel COMP SYNC connector to one Vectorscope Ext Sync Input connector. Connect a 75 Ω end-line termination to the other Ext Sync Input connector.

c. Connect a 75 Ω cable from the 146 rear-panel SUB-CARRIER connector to one Vectorscope Ext CW Φ Ref Input connector. Connect a 75 Ω end-line termination to the other Ext CW Φ Ref Input connector.

d. Rotate the Vectorscope Channel A Phase control to obtain a vector display similar to Fig. 6-23A.

e. While observing the Vectorscope display, set Channel A, 100%-75%-Max Gain switch to 100% and rotate the Channel A Variable Gain control until the short vector on the compass rose is positioned as shown in Fig. 6-23B.

f. Check that the vector starts at the vector graticule center. If not, adjust the Vectorscope Vertical and Horizontal Position Clamps, then repeat Step e.

g. Press the Vectorscope Diff Phase pushbutton, and position the display (as shown in Fig. 6-23C) with the Vertical Position control.

h. CHECK—Differential Gain should be 0.5% or less as measured on the Diff Gain scale on the Vectorscope.

i. Set the 146 APL/IRE LEVEL switch to 50, then 100 and check the differential gain. Should not exceed 0.5% as measured on the vectorscope DIFF GAIN scale.

3. Check Diff Phase

a. Remove the 011-0100-01 Voltage Step Up Termination fixture and connect the 75 Ω coaxial cable directly to the CH A (J1) Input connector. Connect a 75 Ω end-line termination to the other CH A (J2) Input connector.

b. Press the Vectorscope Vector pushbutton, set the 100%-75%-Max Gain switch to Max Gain position, and

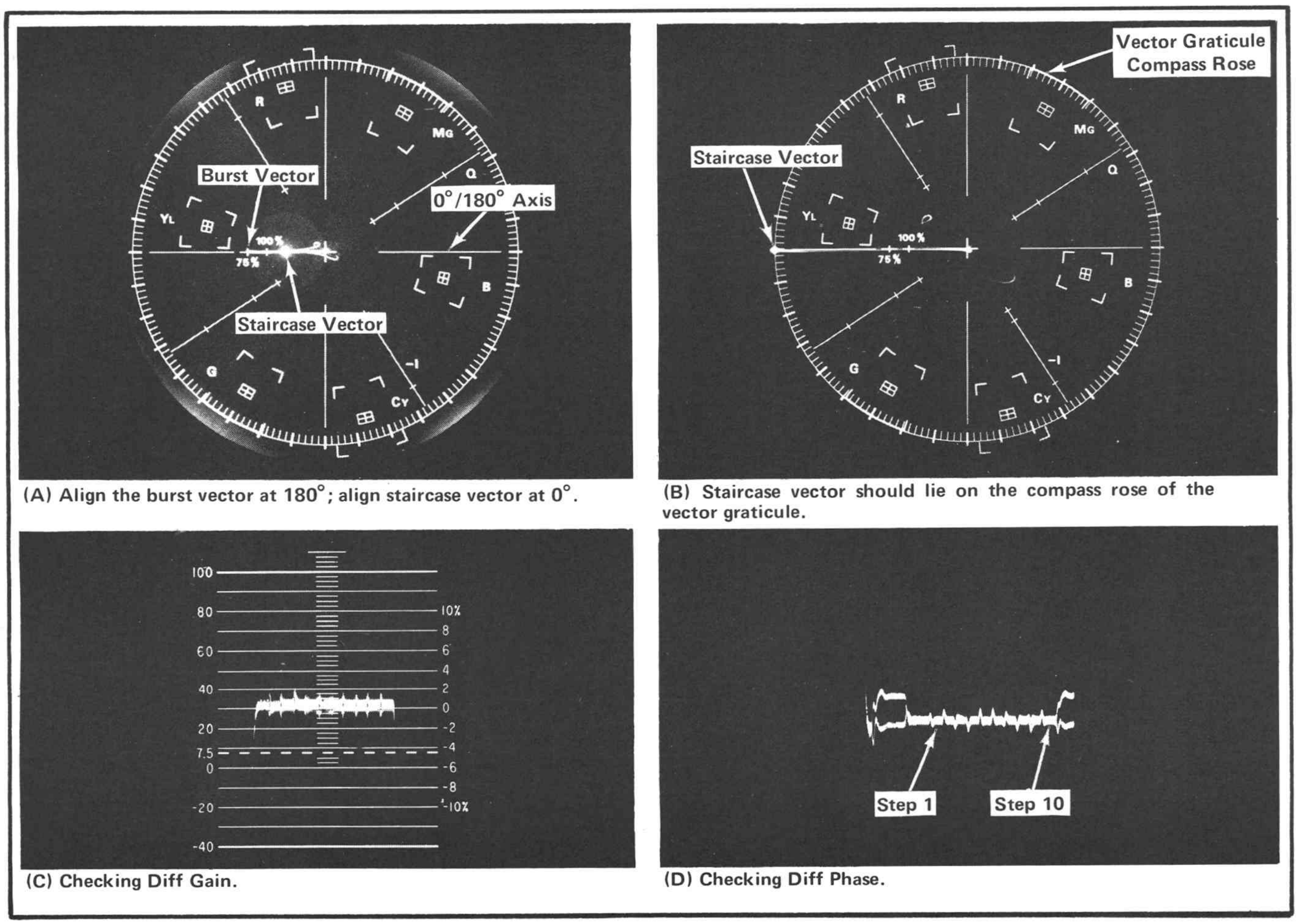


Fig. 6-23. Typical Vectorscope displays used to check differential gain and differential phase.

Ⓐ

rotate the Channel A Variable Gain control to position the display as shown in Fig. 6-23B.

c. Depress the Vectorscope Diff Phase pushbutton. Rotate the Vectorscope A Phase control to center the display, then use the same control as a coarse adjustment to null the first step on the display, as shown in Fig. 6-23D.

d. Rotate the Vectorscope Calibrated Phase control to again null the first step. (The Calibrated Phase control is used as a vernier adjustment.)

e. Note and Record the Calibrated Phase dial reading.

f. Rotate the Calibrated Phase control to null the tenth step.

g. CHECK—Diff Phase, resultant difference, by subtracting dial reading obtained in step e and f. Should not exceed 0.1°.

h. Repeat the procedure (steps c through g) with the 146 APL/IRE LEVEL switch at 0 then 50 positions.

i. Disconnect all test equipment. This completes the 146 calibration. It will now meet all electrical characteristics listed in the Specifications section of this manual.

NOTES

SECTION 7
RACKMOUNTING

Change information, if any, affecting this section will be found at the rear of this manual.

RACKMOUNTING INSTRUCTIONS

Mounting Methods (Figs. 7-1, 7-2, 7-5 and 7-6)

The instruments will fit most commercial consoles and most 19-inch wide racks whose front and rear rail holes conform to Universal, EIA, RETMA and Western Electric hole spacing.

Fig. 7-1 shows the instrument installed in a cabinet type rack with 1 3/4-inch wide slide-out tracks for a non-tilt installation. The instrument is secured into the rack by means of four captive thumb screws. When the thumb screws on the front panel are loosened, the instrument can be pulled out of the rack like a drawer to its fully extended position (see Fig. 7-2). This position permits many routine maintenance functions to be performed without completely removing the instrument from the rack.

The slide-out tracks easily mount to the cabinet rack front and rear vertical mounting rails if the inside distance between the front and rear reails is within 10 1/2 to 24 1/2 inches. Some means of support (for example, make extensions for the rear mounting brackets) is needed for the rear ends of the slide- out tracks if the tracks are going to be installed in a cabinet rack whose inside dimension between front and rear rails is not the proper distance (10 1/2 inches to 24 1/2 inches).

Instrument Dimension

The last page in this section shows dimensional drawings exclusive of the power cord and cables.

Width—A standard 19-inch rack may be used. The dimension or opening between the front rails must be at least 17 5/8 inches (see Fig. 7-2) for a cabinet rack in which the front lip of the stationary section is mounted behind an untapped front rail as shown in the right-hand illustration of Fig. 7-6. This dimension allows room on each side of the instrument for the slide-out tracks to operate so the instrument can move freely in and out of the rack.

Depth—For proper circulation of cooling air, allow at least 2 inches clearance behind the rear of the instrument and any enclosure on the rack (see dimensional drawing). If it is sometimes necessary or desirable to operate the generator in the fully extended position, use cables that are long enough to reach from the instrument to the location where the signal(s) is to be applied.

Rackmounting in a Cabinet Rack

General Information—The slide-out-tracks for the instrument consists of two assemblies, one for the left side of the instrument and one for the right side. Each assembly consists of three sections as illustrated in Fig. 7-3. The stationary section attaches to the front and rear rails of the rack with inside dimensions as indicated in Fig. 7-2; the chassis section attaches to the instrument and is installed at the factory; the intermediate section fits between the other two sections to allow the instrument to be fully extended out of the rack.

The small hardware components included with the slide-out track assemblies are shown in Fig. 7-4. The hardware shown in Fig. 7-4 is used to mount the slide-out tracks to the rack rails having this compatibility.

(a) Front and rear rail holes must be large enough to allow inserting a 10-32 screw through the rail mounting holes (see Fig. 7-6).

(b) Front rail holes may have already been countersunk prior to this installation.

Because of the compatibility given in (b), there will be some screws left over.

The stationary and intermediate sections for both sides of the rack are shipped as a matched set and should not be separated. The matched sets for both sides including hardware are marked 351-0195-00 on the package. To identify the assemblies, note that the automatic latch and intermediate section stop are located near the top of the matched sets when they are properly mated to the chassis sections as shown in Fig. 7-3.

Mounting Procedure—Use the following procedure to mount both sets. See Fig. 7-5 and 7-6 for installation details.

1. To mount the instrument directly above or below another instrument in the cabinet rack, select the appropriate holes in the front rack rails for the stationary sections using Fig. 7-5 as a guide.

2. Mount the stationary slide-out track sections to the front rack rails using either of these methods:

(a) If the front rails are not countersunk, use the pan head screws and bar nuts to mount the stationary sections similar to the right-hand illustration shown in Fig. 7-6.

(b) If the front rails are countersunk, use the flat head screws and bar nuts to mount the stationary sections as shown in Fig. 7-6 right-hand illustration.

3. Mount the stationary slide-out track sections to the non-tapped rear rails using this method:

Mount the left stationary section with hardware provided as shown in the left-hand or center illustration in Fig. 7-6. Note that the rear mounting bracket can be installed either way so the slide-out tracks will fit a deep or shallow cabinet rack. Use Fig. 7-6 as a guide for mounting the right stationary section. Make sure the stationary sections are horizontally aligned so they are level and parallel with each other.

Adjustments

To adjust the slide-out tracks for smooth operation, proceed as follows:

1. Insert the instrument into the rack as described and as shown in steps 1 through 4 of Fig. 7-7 installation procedure.

2. Adjust the slide-out tracks for proper spacing as shown in Fig. 7-8.

Maintenance

The slide-out tracks require no lubrication. The special dark gray finish on the sliding parts is a permanent lubrication.

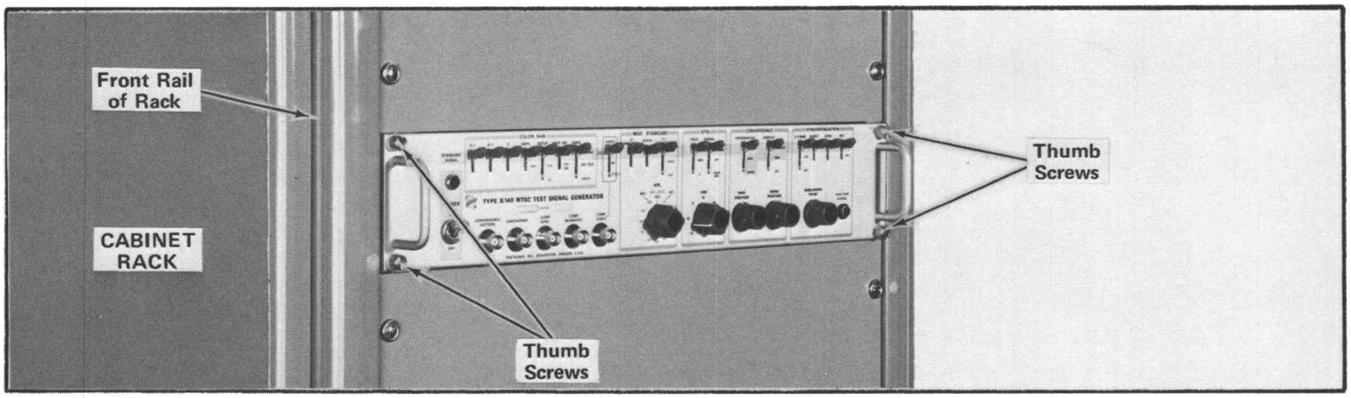


Fig. 7-1. The generator installed in a cabinet rack.

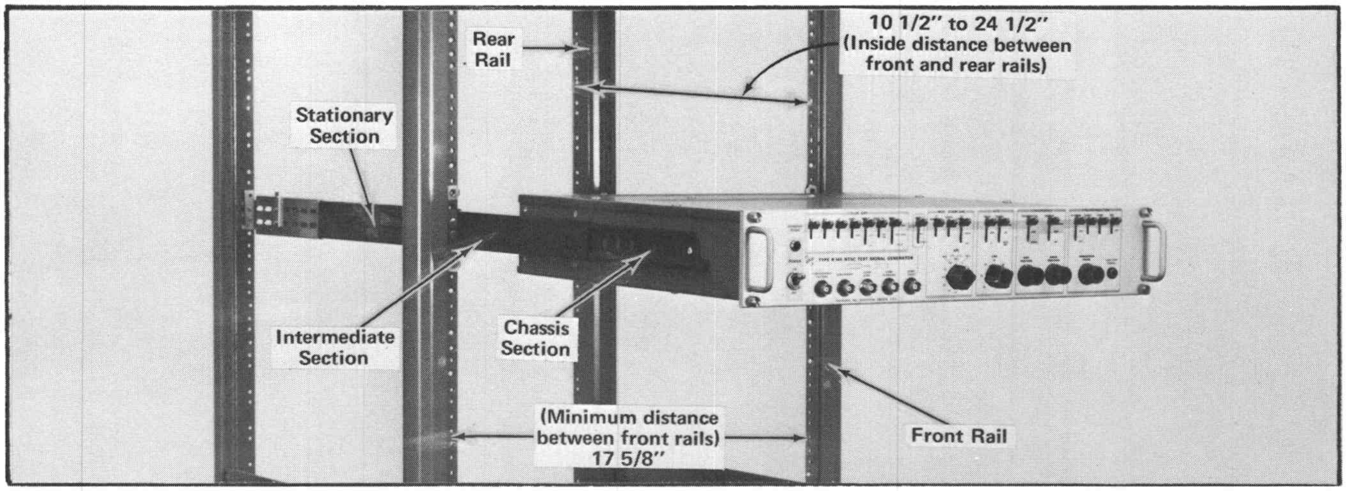


Fig. 7-2. The generator shown in the fully extended position. The cabinet rack sides have been removed from the rack to show mounting.

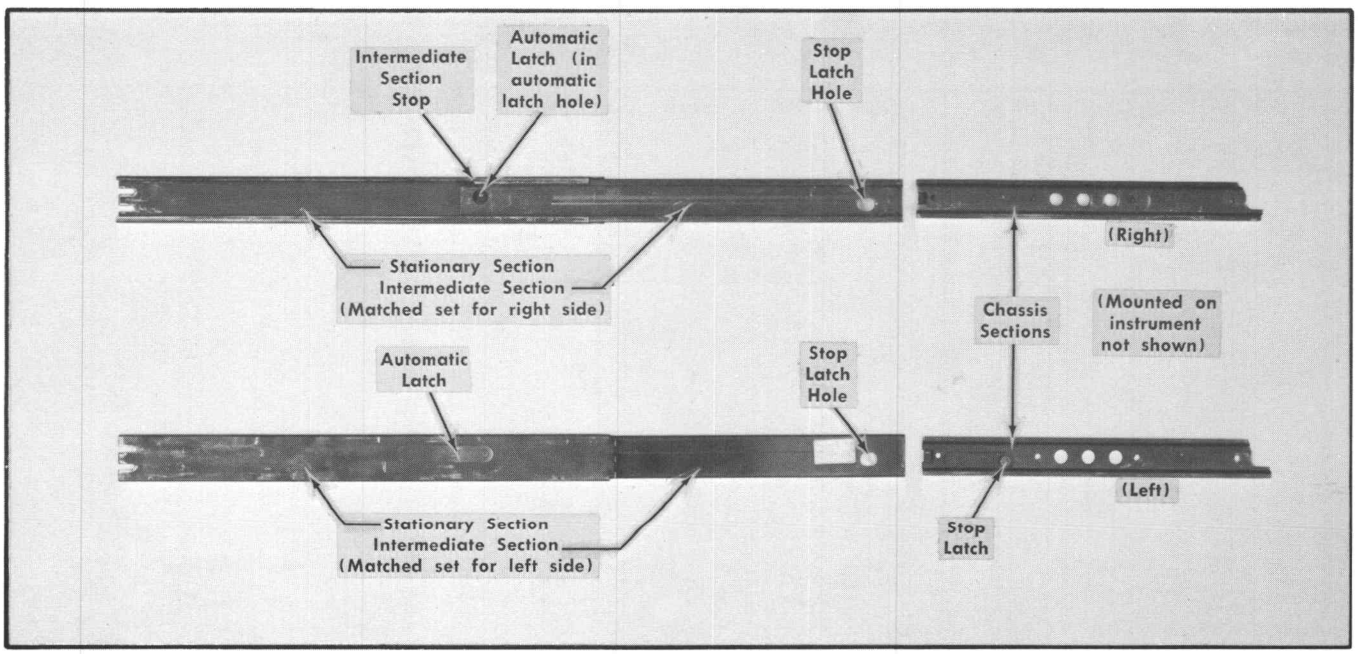


Fig. 7-3. Illustration showing the 1 3/4-inch wide slide-out track assemblies.

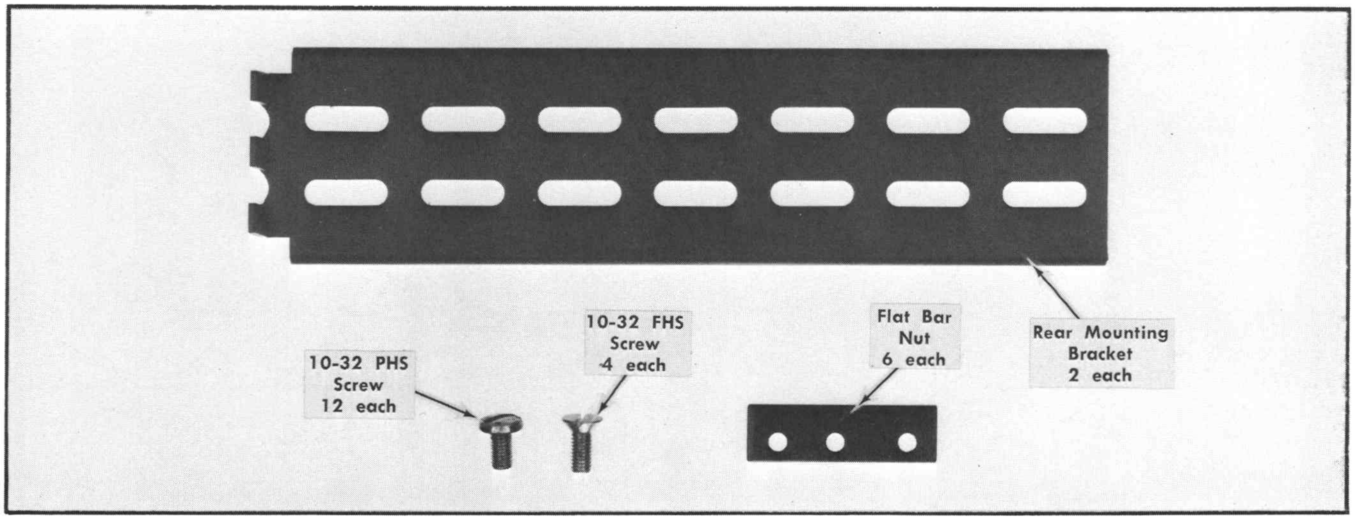


Fig. 7-4. Small hardware components for mounting the stationary sections to the rack rails.

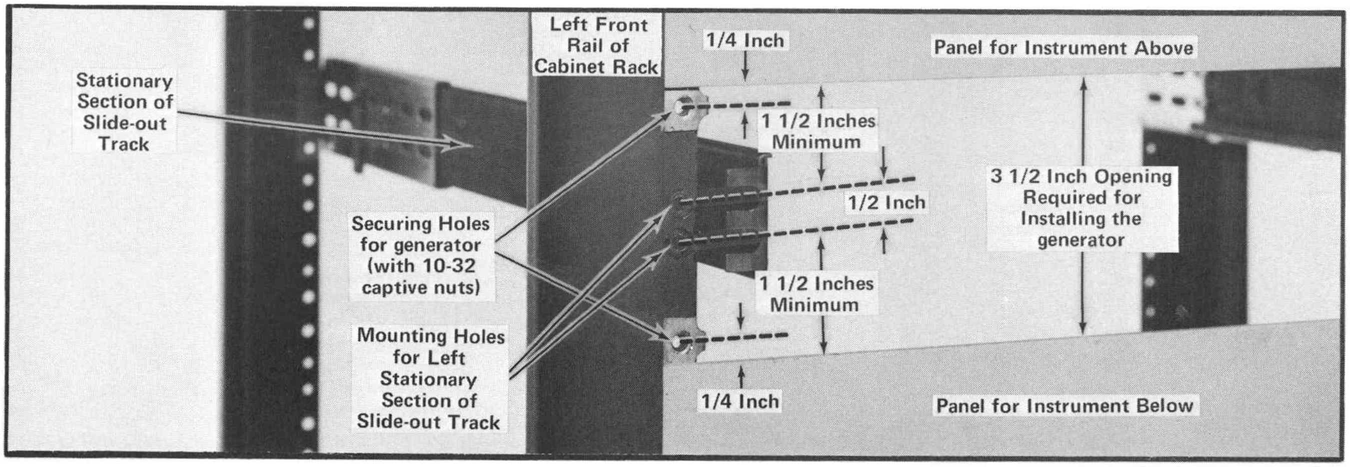


Fig. 7-5. Vertical mounting position of the left stationary section and location of the securing holes. These same dimensions apply to the right front rail.

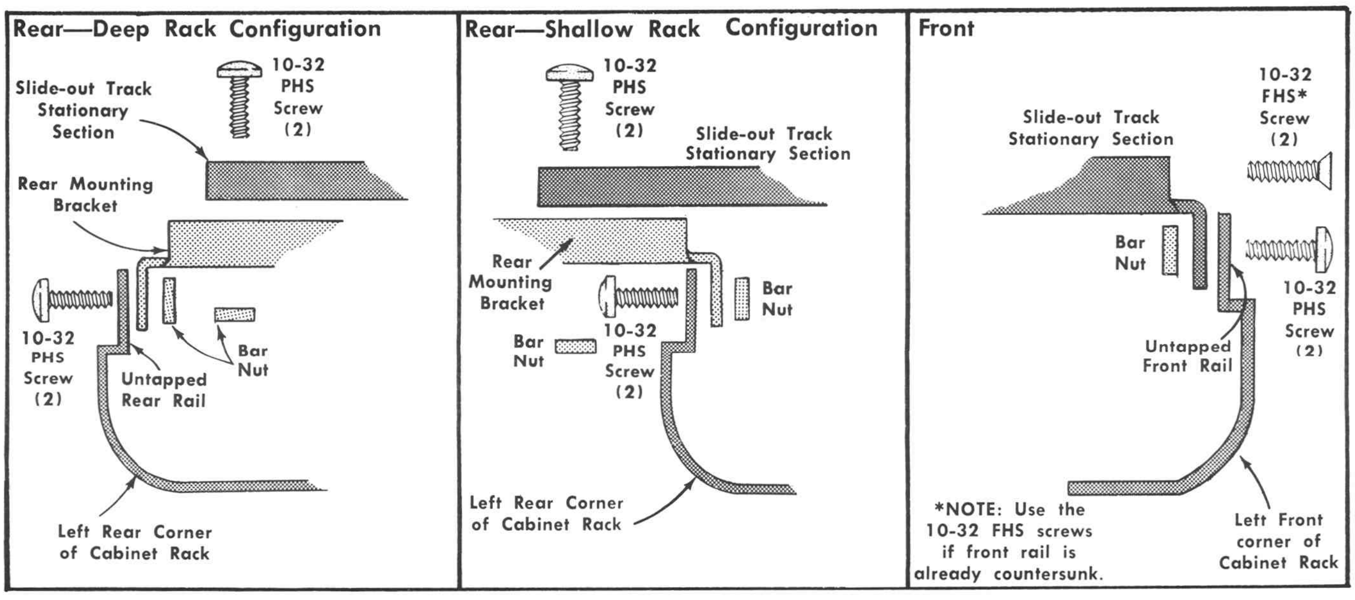


Fig. 7-6. Top view of cabinet rack showing mounting position of the left stationary section to the rails of the rack. Since the rails are not tapped, bar nuts are used to mount the stationary section to the rack rails.

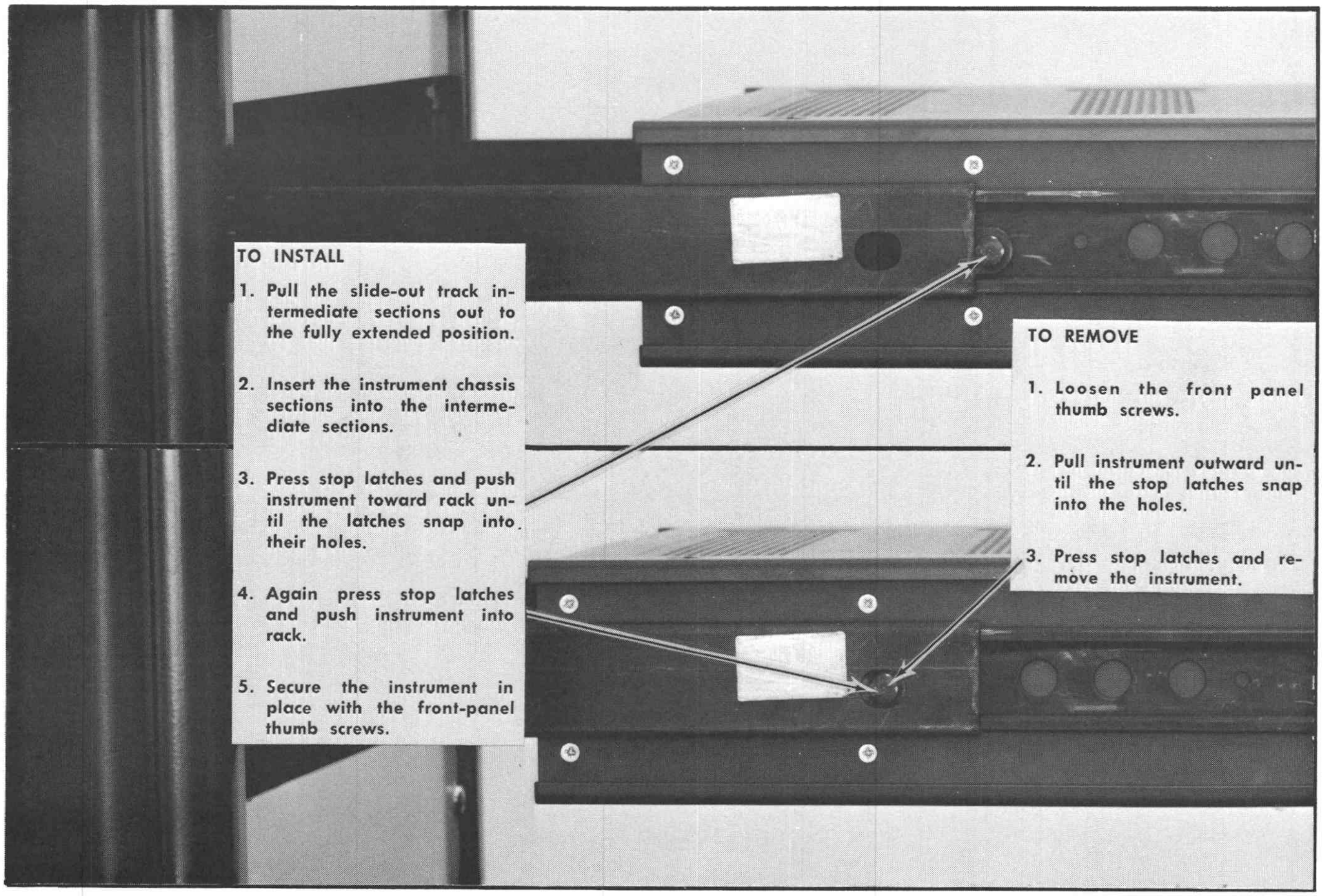


Fig. 7-7. Installing and removing the instrument.

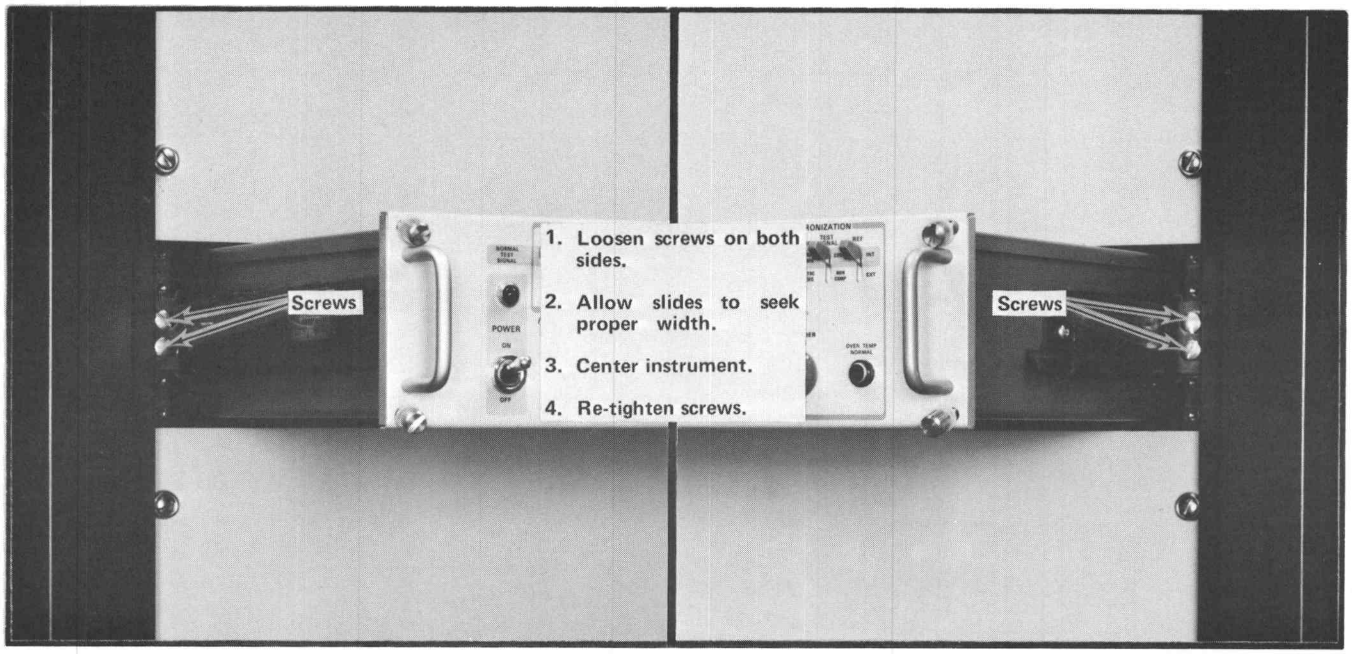
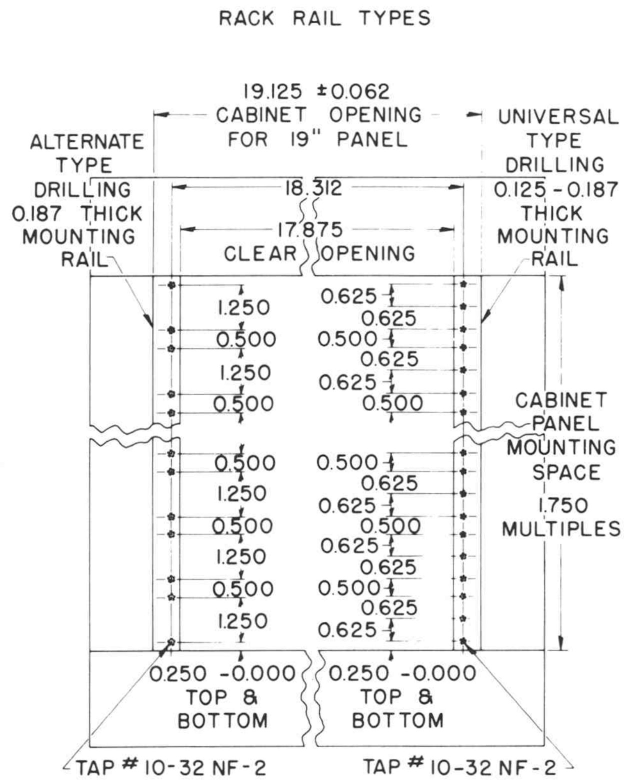
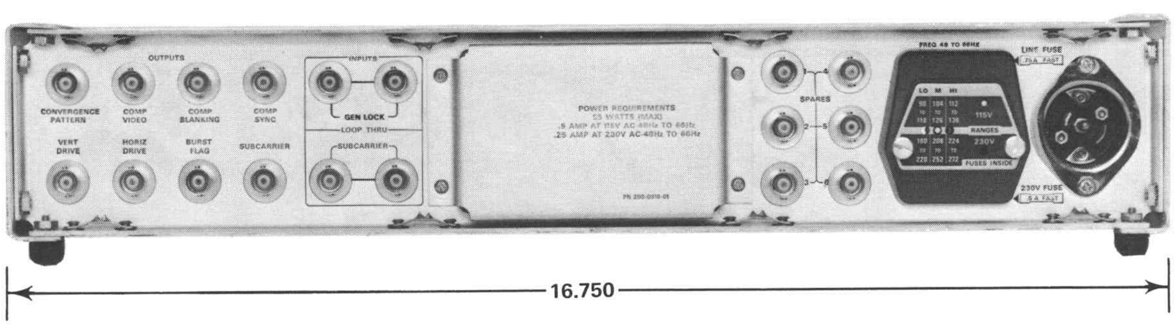
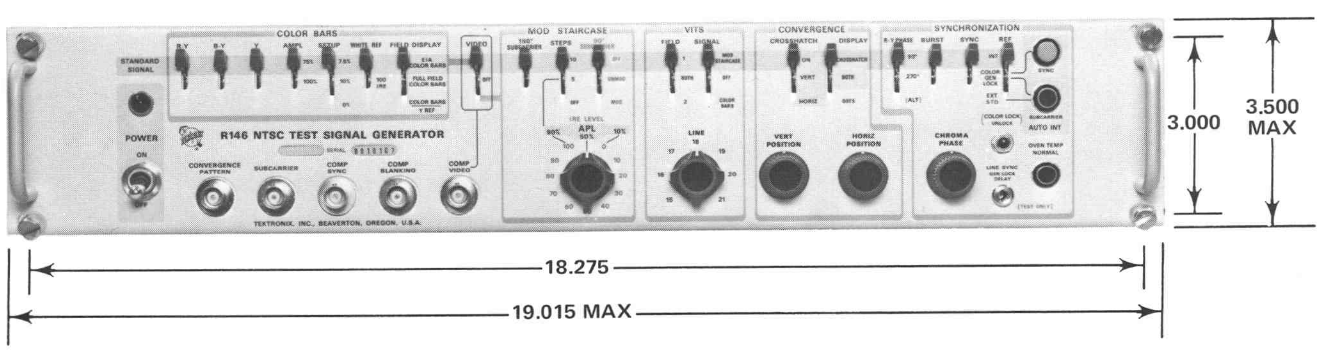


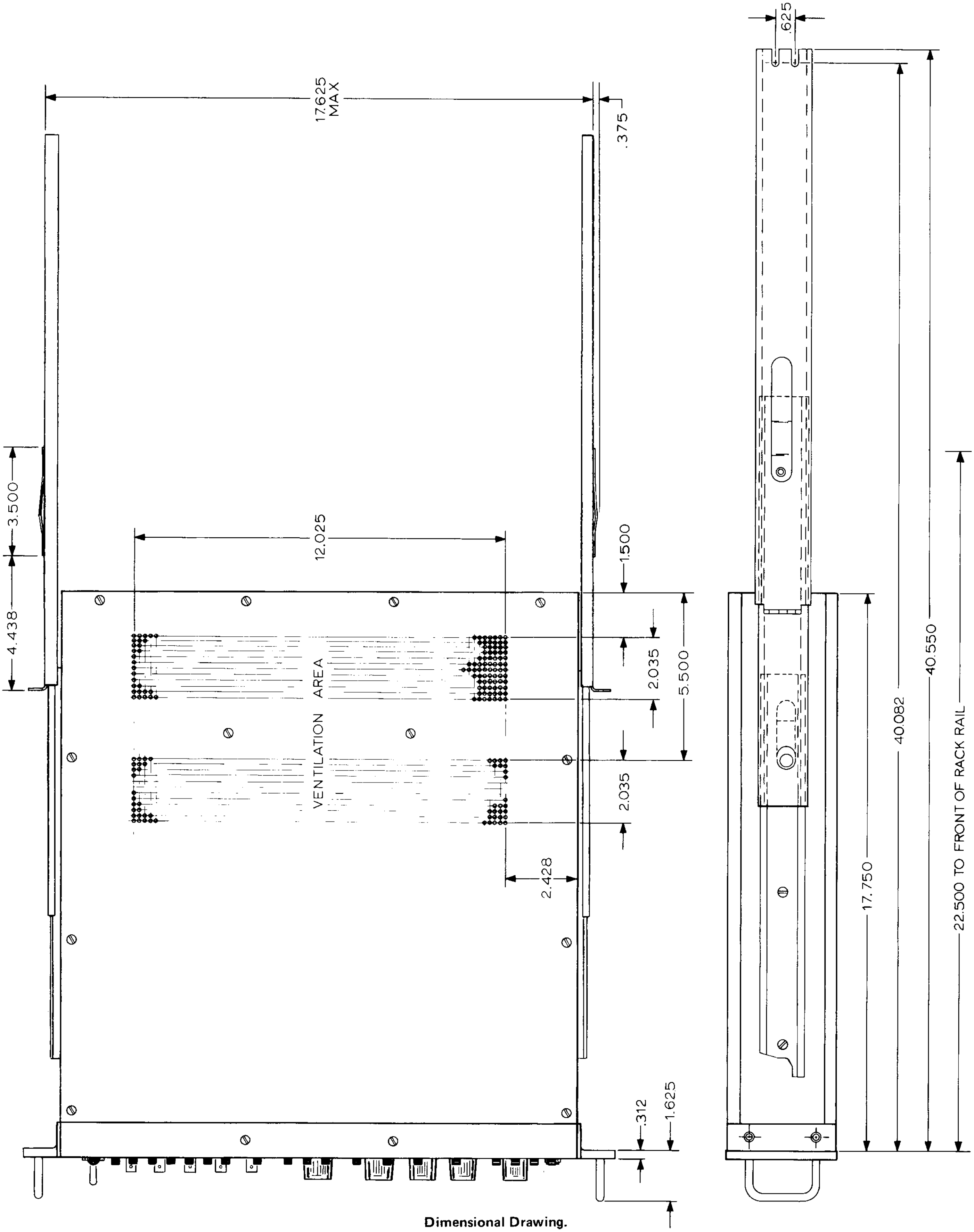
Fig. 7-8. Adjusting the slide-out tracks for smooth sliding action.







Dimensional Drawing.



Dimensional Drawing.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

INDEX OF ELECTRICAL PARTS LIST

Title **Page No.**

SECTION 8
ELECTRICAL PARTS LIST

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

CHASSIS

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C11	290-0334-00			1250 μF	Elect.	50 V	+75%—10%
C42	290-0321-00			11,000 μF	Elect.	15 V	+100%—10%
C61	290-0086-00			2000 μF	Elect.	30 V	
C92[1]							
C94[1]							
C98[1]							
C1161	281-0613-00			10 pF	Cer	200 V	10%

Bulbs

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
DS42	150-0018-00			Incandescent, 6.3 V #12
DS57	150-0064-00			Incandescent, 10 V, 4 mA, amber lens
DS58	150-0066-00			Incandescent, 10 V, 4 mA, red lens
DS88	150-0065-00			Incandescent, 10 V, 4 mA, green lens

Fuses

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
F2	159-0042-00			3/4 A 3AG Fast-Blo
F3	159-0025-00			½ A 3AG Fast-Blo

Filter

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
FL4	119-0095-04			2 x 1A, 275 VAC, 400 Hz

Connectors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
J40	131-0126-00			BNC, single contact
J42	131-0126-00			BNC, single contact
J60	131-0126-00			BNC, single contact
J62	131-0126-00			BNC, single contact
J64	131-0126-00			BNC, single contact

[1]Furnished as a unit with Goniometer (*119-0133-00).

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Connectors (cont)			
J66	131-0126-00			BNC, single contact			
J70	131-0126-00			BNC, single contact			
J72	131-0126-00			BNC, single contact			
J74	131-0126-00			BNC, single contact			
J76	131-0126-00			BNC, single contact			
J80	131-0126-00			BNC, single contact			
J82	131-0126-00			BNC, single contact			
J84	131-0126-00			BNC, single contact			
J86	131-0126-00			BNC, single contact			
J88	131-0126-00			BNC, single contact			
J90	131-0126-00			BNC, single contact			
J92	131-0126-00			BNC, single contact			
				Transistors			
Q35	151-0140-00			Silicon	NPN	TO-3	Selected from 2N3055
Q55	151-0140-00			Silicon	NPN	TO-3	Selected from 2N3055
Q85	*151-0148-00			Silicon	NPN	TO-66	Tek Spec
				Inductors			
L523	276-0588-00			Core, ferrite			
L543	276-0588-00			Core, ferrite			
L5001	276-0588-00			Core, ferrite			

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R50	321-0329-00			26.1 kΩ	1/8 W	Prec	1%
R51	321-0283-00			8.66 kΩ	1/8 W	Prec	1%
R52	321-0254-00			4.32 kΩ	1/8 W	Prec	1%
R53	321-0233-00			2.61 kΩ	1/8 W	Prec	1%
R54	321-0216-00			1.74 kΩ	1/8 W	Prec	1%
R55	321-0202-00			1.24 kΩ	1/8 W	Prec	1%
R56	321-0190-00			931 Ω	1/8 W	Prec	1%
R57	321-0180-00			732 Ω	1/8 W	Prec	1%
R58	321-0170-00			576 Ω	1/8 W	Prec	1%
R60	311-0141-00			2 kΩ, Var			
R62	311-0141-00			2 kΩ, Var			
R64	315-0153-00			15 kΩ	1/4 W		5%
R66	315-0153-00			15 kΩ	1/4 W		5%
R68	311-1005-00			15 kΩ, Var			

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Resistors (cont)		
R94[2]						
R98[2]						
R1131[3]						
R1134[3]						
R1135[3]						
R1136[3]						
R1137[3]						
R1161	315-0272-00			2.7 kΩ	1/4 W	5%
R5001	315-0153-00			15 kΩ	1/4 W	5%
R5751	315-0153-00			15 kΩ	1/4 W	5%
				Switches		
	Wired or Unwired					
S2[4]						
S3[4]						
S4	260-0276-00			Toggle	POWER	
S10	260-0621-00			Lever	R-Y PHASE	
S12	260-0664-00			Lever	AMPL	
S14	260-0621-00			Lever	SET UP	
S16	260-0621-00			Lever	FIELD	
S18	260-1087-00			Rotary	LINE	
S22	260-0807-00			Lever	FIELD DISPLAY	
S24	260-0621-00			Lever	SIGNAL	
S26	260-0621-00			Lever	VIDEO	
S30	260-0731-00			Lever	BURST	
S32	260-0731-00			Lever	B-Y	
S34	260-0731-00			Lever	R-Y	
S36	260-0731-00			Lever	Y	
S38	260-0731-00			Lever	WHITE REF	
S44	260-0621-00			Lever	90° SUBCARRIER	
S46	260-0664-00			Lever	180° SUBCARRIER	
S48	260-0820-00			Lever	STEPS	
S50	260-0731-00			Lever	SYNC	

[2]Furnished as a unit with Goniometer (*119-0133-00).

[3]Furnished as a unit with Partial Oven Assembly (*205-0108-01).

[4]See Mechanical Parts List. Line Voltage Selector Body.

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
				Switches *(Cont'd)*	
S54	260-1088-00			Rotary	APL/IRE LEVEL
S56	260-0621-00			Lever	REF
S62	260-0621-00			Lever	DISPLAY
S64	260-0621-00			Lever	CROSS HATCH
S68	260-0247-00			Pushbutton	COLOR LOCK UNLOCK
S1131[5]					
				Transformers	
T1	*120-0630-00			LV Power	
T95[6]					

A1 MODULATOR Circuit Board Assembly

*670-0301-01 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description			
C104	283-0004-00	0.02 μF	Cer	150 V	
C105	283-0047-00	270 pF	Cer	500 V	5%
C106	283-0047-00	270 pF	Cer	500 V	5%
C114	283-0004-00	0.02 μF	Cer	150 V	
C115	283-0047-00	270 pF	Cer	500 V	5%
C116	283-0047-00	270 pF	Cer	500 V	5%
C117	283-0047-00	270 pF	Cer	500 V	5%
C118	283-0047-00	270 pF	Cer	500 V	5%
C119	290-0134-00	22 μF	Elect.	15 V	
C120	290-0134-00	22 μF	Elect.	15 V	
C121	290-0134-00	22 μF	Elect.	15 V	
C124	283-0004-00	0.02 μF	Cer	150 V	
C125	283-0598-00	253 pF	Mica	300 V	5%
C127	283-0598-00	253 pF	Mica	300 V	5%
C128	283-0004-00	0.02 μF	Cer	150 V	
C129	290-0134-00	22 μF	Elect.	15 V	
C133	281-0116-00	1.6-9.1 pF, Var	Air		
C143	290-0134-00	22 μF	Elect.	15 V	
C152	281-0116-00	1.6-9.1 pF, Var	Air		
C157	281-0116-00	1.6-9.1 pF, Var	Air		

[5]Furnished as a unit with Partial Oven Assembly (*205-0108-01).

[6]Furnished as a unit with Goniometer (*119-0133-00).

A1 MODULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		

Capacitors (cont)

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C162	283-0603-00			113 pF	Mica	300 V	2%
C167	283-0596-00			528 pF	Mica	300 V	1%
C168	283-0603-00			113 pF	Mica	300 V	2%
C173	283-0596-00			528 pF	Mica	300 V	1%
C176	283-0642-00			33 pF	Mica	300 V	±0.5 pF
C177	283-0004-00			0.02 μF	Cer	150 V	
C182	283-0603-00			113 pF	Mica	300 V	2%
C183	283-0004-00			0.02 μF	Cer	150 V	
C184	283-0633-00			77 pF	Mica	100 V	1%
C187	283-0596-00			528 pF	Mica	300 V	1%
C188	283-0603-00			113 pF	Mica	300 V	2%
C193	283-0596-00			528 pF	Mica	300 V	1%

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
CR104	*152-0185-00			Silicon	Replaceable by 1N4152
CR105	*152-0185-00			Silicon	Replaceable by 1N4152

Inductors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
L126	*114-0278-00			4.6-16.7 μH	Core 276-0568-00
L163	*114-0280-00			12-43 μH, Var	Core 276-0568-00
L167	*114-0280-00			12-43 μH, Var	Core 276-0568-00
L176	*114-0281-00			35-70 μH, Var	Core 276-0540-00
L183	*114-0280-00			12-43 μH, Var	Core 276-0568-00
L184	*114-0281-00			35-70 μH, Var	Core 276-0540-00
L187	*114-0280-00			12-43 μH, Var	Core 276-0568-00

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q111	151-0225-00			Silicon	NPN	TO-18	2N3563
Q112	151-0225-00			Silicon	NPN	TO-18	2N3563
Q113	151-0190-00			Silicon	NPN	TO-92	2N3904
Q114	151-0190-00			Silicon	NPN	TO-92	2N3904
Q115	151-0190-00			Silicon	NPN	TO-92	2N3904
Q116	151-0190-00			Silicon	NPN	TO-92	2N3904
Q117	151-0190-00			Silicon	NPN	TO-92	2N3904
Q118	151-0190-00			Silicon	NPN	TO-92	2N3904
Q122	151-0225-00			Silicon	NPN	TO-18	2N3563
Q123	151-0225-00			Silicon	NPN	TO-18	2N3563

A1 MODULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Transistors (cont)			
Q145[7]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q146[8]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q153	151-0232-00			Silicon	NPN	TO-78	Dual
Q155[7]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q156[8]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q157	151-0232-00			Silicon	NPN	TO-78	Dual
Q165[7]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q166[8]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q172	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q173	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q175[7]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q176[8]	*153-0577-00			Silicon	NPN	TO-18	Tek Spec
Q177	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q178	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description		
R100	315-0100-00			10 Ω	¼ W	5%
R101	315-0100-00			10 Ω	¼ W	5%
R102	315-0182-00			1.8 kΩ	¼ W	5%
R103	315-0102-00			1 kΩ	¼ W	5%
R104	315-0752-00			7.5 kΩ	¼ W	5%
R105	315-0103-00			10 kΩ	¼ W	5%
R106	315-0362-00			3.6 kΩ	¼ W	5%
R107	315-0302-00			3 kΩ	¼ W	5%
R108	315-0202-00			2 kΩ	¼ W	5%
R109	315-0100-00			10 Ω	¼ W	5%
R110	315-0100-00			10 Ω	¼ W	5%
R111	315-0152-00			1.5 kΩ	¼ W	5%
R112	315-0102-00			1 kΩ	¼ W	5%
R114	315-0272-00			2.7 kΩ	¼ W	5%
R115	315-0103-00			10 kΩ	¼ W	5%
R116	315-0362-00			3.6 kΩ	¼ W	5%
R117	315-0101-00			100 Ω	¼ W	5%
R118	301-0102-00			1 kΩ	¼ W	5%
R119	315-0202-00			2 kΩ	¼ W	5%
R120	315-0100-00			10 Ω	¼ W	5%

[7]Q146, Q156, Q166 and Q176 furnished as a matched set.

[8]Q146, Q156, Q166 and Q176 furnished as amatched set.

A1 MODULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R123	315-0102-00			1 kΩ	1/4 W		5%
R124	315-0102-00			1 kΩ	1/4 W		5%
R126	315-0102-00			1 kΩ	1/4 W		5%
R127	315-0181-00			180 Ω	1/4 W		5%
R128	321-0122-00			182 Ω	1/8 W	Prec	1%
R129	315-0101-00			100 Ω	1/4 W		5%
R130	321-0159-00			442 Ω	1/8 W	Prec	1%
R131	321-0122-00			182 Ω	1/8 W	Prec	1%
R132	321-0154-00			392 Ω	1/8 W	Prec	1%
R133	321-0154-00			392 Ω	1/8 W	Prec	1%
R134	315-0302-00			3 kΩ	1/4 W		5%
R135	315-0302-00			3 kΩ	1/4 W		5%
R136	321-0154-00			392 Ω	1/8 W	Prec	1%
R137	321-0154-00			392 Ω	1/8 W	Prec	1%
R138	321-0159-00			442 Ω	1/8 W	Prec	1%
R141	321-0812-07			455 Ω	1/8 W	Prec	1/10%
R142	311-0886-00			50 Ω, Var			
R143	315-0202-00			2 kΩ	1/4 W		5%
R144	321-0812-07			455 Ω	1/8 W	Prec	1/10%
R145	315-0181-00			180 Ω	1/4 W		5%
R146	315-0181-00			180 Ω	1/4 W		5%
R147	315-0202-00			2 kΩ	1/4 W		5%
R148	311-0886-00			50 Ω, Var			
R151	321-0735-07			1.001 kΩ	1/8 W	Prec	1/10%
R152	321-0735-07			1.001 kΩ	1/8 W	Prec	1/10%
R155	315-0181-00			180 Ω	1/4 W		5%
R156	315-0181-00			180 Ω	1/4 W		5%
R157	321-0812-07			455 Ω	1/8 W	Prec	1/10%
R158	321-0735-07			1.001 kΩ	1/8 W	Prec	1/10%
R161	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R162	321-0143-00			301 Ω	1/8 W	Prec	1%
R165	315-0181-00			180 Ω	1/4 W		5%
R166	315-0181-00			180 Ω	1/4 W		5%
R167	321-0812-07			455 Ω	1/8 W	Prec	1/10%
R168	321-0735-07			1.001 kΩ	1/8 W	Prec	1/10%
R169	321-0143-00			301 Ω	1/8 W	Prec	1%
R174	321-0193-00			1 kΩ	1/8 W	Prec	1%
R175	315-0181-00			180 Ω	1/4 W		5%
R176	315-0181-00			180 Ω	1/4 W		5%
R177	315-0102-00			1 kΩ	1/4 W		5%

A1 MODULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R178	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R179	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R182	321-0143-00			301 Ω	1/8 W	Prec	1%
R183	321-0335-00			30.1 kΩ	1/8 W	Prec	1%
R186	315-0302-00			3 kΩ	1/4 W		5%
R188	321-0143-00			301 Ω	1/8 W	Prec	1%
R193	315-0102-00			1 kΩ	1/4 W		5%
R194	315-0302-00			3 kΩ	1/4 W		5%
				Transformers			
T127	*120-0631-00			Toroid, 10 turns trifilar			
T136	*120-0584-00			Toroid, three 10 turn windings			
T144	*120-0587-00			Toroid, four 10 turn windings			
T174	*120-0524-00			Toroid, 12 turns quadfilar			
				Integrated Circuit			
U102	156-0012-00			Clocked J-K flip-flop Replaceable by Fairchild μL9923			

A2 BAR TIMING Circuit Board Assembly

*670-0302-02 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C207	281-0022-00			8-50 pF, Var	Cer		
C208	283-0600-00			43 pF	Mica	500 V	5%
C209	290-0134-00			22 μF	Elect.	15 V	
C212	283-0080-00			0.022 μF	Cer	25 V	+80% −20%
C215	283-0047-00			270 pF	Cer	500 V	5%
C216	283-0026-00			0.2 μF	Cer	25 V	
C218	283-0641-00			180 pF	Cer	100 V	1%
C223	283-0026-00			10 μF	Cer	25 V	
C224	281-0638-00			240 pF	Cer	500 V	5%
C227	281-0022-00			8-50 pF, Var	Cer		
C231	283-0026-00			0.2 μF	Cer	25 V	
C252	283-0598-00			253 pF	Mica	300 V	5%

A2 BAR TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Semiconductor Device, Diodes
CR202	*152-0185-00			Silicon Replaceable by 1N4152
CR206	*152-0185-00			Silicon Replaceable by 1N4152
CR251	*152-0185-00			Silicon Replaceable by 1N4152
CR261	*152-0185-00			Silicon Replaceable by 1N4152
CR271	*152-0185-00			Silicon Replaceable by 1N4152
CR281	*152-0185-00			Silicon Replaceable by 1N4152
				Inductors
L217	114-0177-00			280-650 μH, Var Core 276-0506-00
				Transistors
Q203	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q206	151-0224-00			Silicon NPN TO-18 2N3692
Q208	151-0225-00			Silicon NPN TO-18 2N3563
Q213	151-0224-00			Silicon NPN TO-18 2N3692
Q216	151-0220-00			Silicon PNP TO-18 2N4122
Q218	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q221	151-0220-00			Silicon PNP TO-18 2N4122
Q223	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q226	151-0225-00			Silicon NPN TO-18 2N3563
Q228	151-0225-00			Silicon NPN TO-18 2N3563
Q233	*151-0129-00			Silicon PNP TO-18 Replaceable by 2N4250
Q236	151-0220-00			Silicon PNP TO-18 2N4122
Q237	151-0225-00			Silicon NPN TO-18 2N3563
Q238	*151-0198-00			Silicon NPN TO-92 Replaceable by MPS918
Q251	151-0224-00			Silicon NPN TO-18 2N3692
Q252	151-0224-00			Silicon NPN TO-18 2N3692
Q261	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q262	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q281	151-0224-00			Silicon NPN TO-18 2N3692
Q282	151-0224-00			Silicon NPN TO-18 2N3692
Q291	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q292	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521

A2 BAR TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R201	321-0126-00			200 Ω	1/8 W	Prec	1%
R202	321-0168-00			549 Ω	1/8 W	Prec	1%
R203	315-0470-00			47 Ω	1/4 W		5%
R204	315-0273-00			27 kΩ	1/4 W		5%
R205	315-0103-00			10 kΩ	1/4 W		5%
R206	315-0681-00			680 Ω	1/4 W		5%
R207	315-0470-00			47 Ω	1/4 W		5%
R208	315-0152-00			1.5 kΩ	1/4 W		5%
R212	315-0470-00			47 Ω	1/4 W		5%
R213	321-0259-00			4.87 kΩ	1/8 W	Prec	1%
R214	321-0213-00			1.62 kΩ	1/8 W	Prec	1%
R215	321-0130-00			221 Ω	1/8 W	Prec	1%
R216	315-0202-00			2 kΩ	1/4 W		5%
R217	315-0470-00			47 Ω	1/4 W		5%
R218	315-0681-00			680 Ω	1/4 W		5%
R219	315-0152-00			1.5 kΩ	1/4 W		5%
R221	315-0102-00			1 kΩ	1/4 W		5%
R222	315-0163-00			16 kΩ	1/4 W		5%
R223	315-0473-00			47 kΩ	1/4 W		5%
R224	315-0102-00			1 kΩ	1/4 W		5%
R225	315-0152-00			1.5 kΩ	1/4 W		5%
R226	315-0152-00			1.5 kΩ	1/4 W		5%
R227	315-0681-00			680 Ω	1/4 W		5%
R231	311-0950-00			10 kΩ, Var			
R232	311-0836-00			5 kΩ, Var			
R233	315-0102-00			1 kΩ	1/4 W		5%
R234	315-0471-00			470 Ω	1/4 W		5%
R235	311-0953-00			2.5 kΩ, Var			
R236	315-0102-00			1 kΩ	1/4 W		5%
R237	315-0132-00			1.3 kΩ	1/4 W		5%
R238	321-0193-00			1 kΩ	1/8 W	Prec	1%
R239	315-0102-00			1 kΩ	1/4 W		5%
R241	321-0359-00			53.6 kΩ	1/8 W	Prec	1%
R253	321-0342-00			35.7 kΩ	1/8 W	Prec	1%
R254	315-0102-00			1 kΩ	1/4 W		5%
R261	315-0101-00			100 Ω	1/4 W		5%
R262	315-0102-00			1 kΩ	1/4 W		5%
R263	315-0101-00			100 Ω	1/4 W		5%
R271	311-0836-00			5 kΩ, Var			
R272	311-0950-00			10 kΩ, Var			

A2 BAR TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R273	321-0342-00			35.7 kΩ	1/8 W	Prec	1%
R281	321-0359-00			53.6 kΩ	1/8 W	Prec	1%
R291	315-0101-00			100 Ω	1/4 W		5%
R292	315-0471-00			470 Ω	1/4 W		5%
				Integrated Circuits			
U243	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U245	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U247	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U248	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U253	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U255	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U257	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U258	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U263	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U265	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U267	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U268	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U273	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U275	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U277	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U278	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923			
U293	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U295	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U297	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U298	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			

A3 FIELD TIMING Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description				
	*670-1000-00			Complete Board				

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C338	283-0032-00			470 pF	Cer	500 V	5%
C366	283-0032-00			470 pF	Cer	500 V	5%
C368	283-0104-00			2000 pF	Cer	500 V	5%
C372	283-0032-00			470 pF	Cer	500 V	5%
C388	283-0032-00			470 pF	Cer	500 V	5%

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q311	151-0224-00			Silicon	NPN	TO-18	2N3692
Q312	151-0224-00			Silicon	NPN	TO-18	2N3692
Q314	151-0224-00			Silicon	NPN	TO-18	2N3692
Q316	151-0224-00			Silicon	NPN	TO-18	2N3692
Q317	151-0224-00			Silicon	NPN	TO-18	2N3692
Q318	151-0224-00			Silicon	NPN	TO-18	2N3692
Q319	151-0224-00			Silicon	NPN	TO-18	2N3692
Q333	151-0207-00			Silicon	NPN	TO-98	2N3415
Q381	151-0207-00			Silicon	NPN	TO-98	2N3415
Q384	151-0207-00			Silicon	NPN	TO-98	2N3415
Q385	151-0207-00			Silicon	NPN	TO-98	2N3415
Q387	151-0207-00			Silicon	NPN	TO-98	2N3415
Q388	151-0207-00			Silicon	NPN	TO-98	2N3415
Q394	151-0207-00			Silicon	NPN	TO-98	2N3415
Q397	151-0207-00			Silicon	NPN	TO-98	2N3415
Q398	151-0207-00			Silicon	NPN	TO-98	2N3415

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description		
R311	315-0102-00			1 kΩ	¼ W	5%
R312	315-0102-00			1 kΩ	¼ W	5%
R314	315-0102-00			1 kΩ	¼ W	5%
R316	315-0102-00			1 kΩ	¼ W	5%
R317	315-0102-00			1 kΩ	¼ W	5%
R318	315-0102-00			1 kΩ	¼ W	5%
R319	315-0102-00			1 kΩ	¼ W	5%
R332	315-0182-00			1.8 kΩ	¼ W	5%
R338	315-0272-00			2.7 kΩ	¼ W	5%
R339	315-0272-00			2.7 kΩ	¼ W	5%

A3 FIELD TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Resistors (cont)		
R361	315-0561-00			560 Ω	1/4 W	5%
R365	315-0243-00			24 kΩ	1/4 W	5%
R366	315-0202-00			2 kΩ	1/4 W	5%
R367	315-0272-00			2.7 kΩ	1/4 W	5%
R368	315-0272-00			2.7 kΩ	1/4 W	5%
R369	315-0272-00			2.7 kΩ	1/4 W	5%
R372	315-0272-00			2.7 kΩ	1/4 W	5%
R374	315-0272-00			2.7 kΩ	1/4 W	5%
R391	315-0272-00			2.7 kΩ	1/4 W	5%
R392	315-0102-00			1 kΩ	1/4 W	5%
R394	315-0102-00			1 kΩ	1/4 W	5%
R396	315-0751-00			750 Ω	1/4 W	5%
R397	315-0102-00			1 kΩ	1/4 W	5%
R398	315-0152-00			1.5 kΩ	1/4 W	5%
R399	315-0102-00			1 kΩ	1/4 W	5%
				Integrated Circuits		
U301	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U302	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U304	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U306	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U308	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U309	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U321	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U322	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U324	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U326	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U328	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U329	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U336	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U338	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U341	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		

A3 FIELD TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
		Integrated Circuits (cont)		
U342	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U344	156-0011-00			Medium power dual 2-input gate Replaceable by Fairchild μL9914
U346	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U348	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U349	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U361	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U362	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U364	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U366	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U368	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U369	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U371	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U372	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U374	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U376	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U378	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U379	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U391	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U392	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U396	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U399	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
	*670-0959-01			Complete Board			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C401	281-0650-00			18 pF	Cer	200 V	10%
C406	281-0613-00			10 pF	Cer	200 V	10%
C407	281-0613-00			10 pF	Cer	200 V	10%
C410	281-0616-00			6.8 pF	Cer	200 V	
C422	281-0022-00			8-50 pF, Var	Cer		
C427	281-0022-00			8-50 pF, Var	Cer		
C430	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C431	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C445	281-0650-00			18 pF	Cer	200 V	10%
C451	283-0596-00			528 pF	Mica	300 V	1%
C452	283-0051-00			0.0033 μF	Cer	100 V	5%
C455	283-0643-00			22 pF	Mica	300 V	±0.5 pF
C456	283-0602-00			53 pF	Mica	300 V	5%
C458	283-0594-00			0.001 μF	Mica	100 V	1%
C459	283-0634-00			65 pF	Mica	100 V	1%
C463	281-0616-00			6.8 pF	Cer	200 V	
C465	283-0636-00			36 pF	Mica	100 V	±0.5 pF
C467	283-0610-00			220 pF	Mica	500 V	5%
C468	283-0622-00			450 pF	Mica	300 V	1%
C469	283-0640-00			160 pF	Mica	100 V	1%
C471	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C477	283-0185-00			2.5 pF	Cer	50 V	5%
C478	283-0632-00			87 pF	Mica	100 V	1%
C479	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C484	283-0003-00			0.01 μF	Cer	150 V	
C487	283-0003-00			0.01 μF	Cer	150 V	
C489	283-0059-00			1 μF	Cer	25 V	+80%—20%
C491	283-0017-00			1 μF	Cer	3 V	
C492	283-0026-00			0.2 μF	Cer	25 V	
C493	283-0026-00			0.2 μF	Cer	25 V	
C495	290-0134-00			22 μF	Elect.	15 V	
C496	290-0309-00			100 μF	Elect.	25 V	

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
CR406	*152-0185-00			Silicon	Replaceable by 1N4152
CR421	*152-0185-00			Silicon	Replaceable by 1N4152
CR422	*152-0185-00			Silicon	Replaceable by 1N4152
CR424	*152-0185-00			Silicon	Replaceable by 1N4152
CR425	*152-0185-00			Silicon	Replaceable by 1N4152

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Semiconductor Device, Diodes (cont)
CR426	*152-0185-00			Silicon Replaceable by 1N4152
CR428	*152-0185-00			Silicon Replaceable by 1N4152
CR441	*152-0185-00			Silicon Replaceable by 1N4152
CR442	*152-0185-00			Silicon Replaceable by 1N4152
CR443	*152-0185-00			Silicon Replaceable by 1N4152
CR453	*152-0185-00			Silicon Replaceable by 1N4152
CR460	*152-0185-00			Silicon Replaceable by 1N4152
CR461	*152-0185-00			Silicon Replaceable by 1N4152
CR462	*152-0185-00			Silicon Replaceable by 1N4152
CR463	*152-0185-00			Silicon Replaceable by 1N4152
CR472	*152-0185-00			Silicon Replaceable by 1N4152
CR479	*152-0185-00			Silicon Replaceable by 1N4152
				Relay
K495	*148-0034-00			Armature, DPDT, 15 V DC
				Inductors
L456	*114-0222-00			2-6 μH, Var Core 276-0568-00
L458	*114-0278-00			4.6-16.7 μH, Var Core 276-0568-00
L466	*114-0222-00			2-6 μH, Var Core 276-0568-00
L468	*114-0278-00			4.6-16.7 μH, Var Core 276-0568-00
				Transistors
Q400	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q402	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q403	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q404	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q406	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q407	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q408	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q420	151-0224-00			Silicon NPN TO-18 2N3692
Q422	151-0224-00			Silicon NPN TO-18 2N3692
Q423	151-0224-00			Silicon NPN TO-18 2N3692
Q424	151-0224-00			Silicon NPN TO-18 2N3692
Q426	151-0224-00			Silicon NPN TO-18 2N3692
Q427	151-0224-00			Silicon NPN TO-18 2N3692
Q428	151-0224-00			Silicon NPN TO-18 2N3692
Q430	151-0220-00			Silicon PNP TO-18 2N4122

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Transistors (cont)

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q431	151-0224-00			Silicon	NPN	TO-18	2N3692
Q433	151-0224-00			Silicon	NPN	TO-18	2N3692
Q434	151-0224-00			Silicon	NPN	TO-18	2N3692
Q435	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q436	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q437	151-0220-00			Silicon	PNP	TO-18	2N4122
Q441	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q443	151-0224-00			Silicon	NPN	TO-18	2N3692
Q445	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q446	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q447	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q450	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q451	151-0207-00			Silicon	NPN	TO-98	2N3415
Q452	151-0225-00			Silicon	NPN	TO-18	2N3563
Q453	151-0225-00			Silicon	NPN	TO-18	2N3563
Q454	151-0224-00			Silicon	NPN	TO-18	2N3692
Q455	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q456	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q463	151-0224-00			Silicon	NPN	TO-18	2N3692
Q465	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q471	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q473	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q474	151-0220-00			Silicon	PNP	TO-18	2N4122
Q475	151-0220-00			Silicon	PNP	TO-18	2N4122
Q476	151-0220-00			Silicon	PNP	TO-18	2N4122
Q477	151-0220-00			Silicon	PNP	TO-18	2N4122
Q478	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q481	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q484	*151-0103-00			Silicon	NPN	TO-5	Replaceable by 2N2219
Q487	*151-0103-00			Silicon	NPN	TO-5	Replaceable by 2N2219
Q491	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R400	321-0363-00			59 kΩ	⅛ W	Prec	1%
R401	321-0294-00			11.3 kΩ	⅛ W	Prec	1%
R402	315-0101-00			100 Ω	¼ W		5%
R403	315-0101-00			100 Ω	¼ W		5%
R404	321-0331-00			27.4 kΩ	⅛ W	Prec	1%

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R406	321-0346-00			39.2 kΩ	1/8 W	Prec	1%
R407	321-0318-00			20 kΩ	1/8 W	Prec	1%
R408	315-0101-00			100 Ω	1/4 W		5%
R409	315-0101-00			100 Ω	1/4 W		5%
R410	311-0950-00			10 kΩ, Var			
R412	311-0732-00			1 kΩ, Var			
R413	311-0732-00			1 kΩ, Var			
R414	311-0840-00			20 kΩ, Var			
R416	311-0836-00			5 kΩ, Var			
R417	311-0953-00			2.5 kΩ, Var			
R418	321-0299-00			12.7 kΩ	1/8 W	Prec	1%
R419	311-0953-00			2.5 kΩ, Var			
R421	315-0102-00			1 kΩ	1/4 W		5%
R422	321-0287-00			9.53 kΩ	1/8 W	Prec	1%
R423	315-0101-00			100 Ω	1/4 W		5%
R424	315-0681-00			680 Ω	1/4 W		5%
R427	315-0821-00			820 Ω	1/4 W		5%
R428	315-0101-00			100 Ω	1/4 W		5%
R429	315-0270-00			27 Ω	1/4 W		5%
R430	315-0474-00			470 Ω	1/4 W		5%
R431	315-0204-00			200 kΩ	1/4 W		5%
R432	315-0151-00			150 Ω	1/4 W		5%
R433	311-0704-00			500 Ω, Var			
R434	311-0704-00			500 Ω, Var			
R435	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R436	315-0101-00			100 Ω	1/4 W		5%
R437	321-0294-00			11.3 kΩ	1/8 W	Prec	1%
R438	315-0101-00			100 Ω	1/4 W		5%
R439	315-0752-00			7.5 kΩ	1/4 W		5%
R440	315-0183-00			18 kΩ	1/4 W		5%
R441	321-0396-00			130 kΩ	1/8 W	Prec	1%
R442	315-0103-00			10 kΩ	1/4 W		5%
R443	311-0953-00			2.5 kΩ, Var			
R444	321-0258-00			4.75 kΩ	1/8 W	Prec	1%
R445	321-0308-00			15.8 kΩ	1/8 W	Prec	1%
R446	321-0294-00			11.3 kΩ	1/8 W	Prec	1%
R447	315-0101-00			100 Ω	1/4 W		5%
R448	315-0102-00			1 kΩ	1/4 W		5%
R449	315-0102-00			1 kΩ	1/4 W		5%
R450	315-0681-00			680 Ω	1/4 W		5%
R451	315-0102-00			1 kΩ	1/4 W		5%

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R452	315-0101-00			100 Ω	¼ W		5%
R453	311-0953-00			2.5 kΩ, Var			
R454	311-0732-00			1 kΩ, Var			
R455	321-0304-00			14.3 kΩ	⅛ W	Prec	1%
R456	315-0101-00			100 Ω	¼ W		5%
R457	321-0108-00			130 Ω	⅛ W	Prec	1%
R458	321-0117-00			162 Ω	⅛ W	Prec	1%
R459	321-0172-00			604 Ω	⅛ W	Prec	1%
R460	315-0472-00			4.7 kΩ	¼ W		5%
R461	315-0273-00			27 kΩ	¼ W		5%
R462	315-0561-00			560 Ω	¼ W		5%
R463	311-0950-00			10 kΩ, Var			
R464	321-0349-00			42.2 kΩ	⅛ W	Prec	1%
R465	321-0280-00			8.06 kΩ	⅛ W	Prec	1%
R466	321-0210-00			1.5 kΩ	⅛ W	Prec	1%
R467	321-0181-00			750 Ω	⅛ W	Prec	1%
R468	321-0241-00			3.16 kΩ	⅛ W	Prec	1%
R469	321-0197-00			1.1 kΩ	⅛ W	Prec	1%
R470	315-0473-00			47 kΩ	¼ W		5%
R471	315-0393-00			39 kΩ	¼ W		5%
R472	315-0512-00			5.1 kΩ	¼ W		5%
R473	321-0228-00			2.32 kΩ	⅛ W	Prec	1%
R474	315-0431-00			430 Ω	¼ W		5%
R475	321-0210-00			1.5 kΩ	⅛ W	Prec	1%
R476	321-0210-00			1.5 kΩ	⅛ W	Prec	1%
R477	315-0431-00			430 Ω	¼ W		5%
R478	311-0827-00			250 Ω, Var			
R479	321-0228-00			2.32 kΩ	⅛ W	Prec	1%
R480	315-0181-00			180 Ω	¼ W		5%
R481	321-0172-00			604 Ω	⅛ W	Prec	1%
R482	311-0704-00			500 Ω, Var			
R483	315-0302-00			3 kΩ	¼ W		5%
R484	321-0231-00			2.49 kΩ	⅛ W	Prec	1%
R485	321-0210-00			1.5 kΩ	⅛ W	Prec	1%
R486	321-0231-00			2.49 kΩ	⅛ W	Prec	1%
R487	321-0085-00			75 Ω	⅛ W	Prec	1%
R488[9]	*312-0656-00			121 Ω	⅛ W	Prec	1/10%
R489	315-0302-00			3 kΩ	¼ W		5%
R490	315-0473-00			47 kΩ	¼ W		5%
R491	315-0393-00			39 kΩ	¼ W		5%

[9]Matched pair with R497.

A4 BAR DRIVE & VIDEO OUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R492	321-0277-00			7.5 kΩ	1/8 W	Prec	1%
R493	308-0252-00			390 Ω	3 W	WW	5%
R494 } R495 }	*312-0657-00			200 Ω	1/8 W	Prec (matched pair)	
R496	321-0085-00			75 Ω	1/8 W	Prec	1%
R497[10]	*312-0656-00			121 Ω	1/8 W	Prec	1/10%
R498	308-0314-00			680 Ω	3 W	WW	5%
R499	311-0884-00			100 , Var			
R500	315-0910-00			91 Ω	1/4 W		5%

A5 STAIRCASE Circuit Board Assembly

*670-1347-00 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description			
C506	283-0080-00	0.022 μF	Cer	25 V	+80%—20%
C523	283-0028-00	0.0022 μF	Cer	50 V	
C543	283-0028-00	0.0022 μF	Cer	50 V	
C547	283-0032-00	470 pF	Cer	500 V	5%
C559	283-0060-00	100 pF	Cer	200 V	5%
C560	283-0060-00	100 pF	Cer	200 V	5%
C568	290-0215-00	100 μF	Elect.	25 V	

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Description	
CR511	*152-0185-00	Silicon	Replaceable by 1N4152
CR512	*152-0185-00	Silicon	Replaceable by 1N4152
CR513	*152-0185-00	Silicon	Replaceable by 1N4152
CR514	*152-0185-00	Silicon	Replaceable by 1N4152
CR521	*152-0185-00	Silicon	Replaceable by 1N4152
CR522	*152-0185-00	Silicon	Replaceable by 1N4152
CR523	*152-0185-00	Silicon	Replaceable by 1N4152
CR524	*152-0185-00	Silicon	Replaceable by 1N4152
CR533	*152-0185-00	Silicon	Replaceable by 1N4152
CR534	*152-0185-00	Silicon	Replaceable by 1N4152
CR542	*152-0185-00	Silicon	Replaceable by 1N4152
CR545	*152-0185-00	Silicon	Replaceable by 1N4152
CR548	*152-0185-00	Silicon	Replaceable by 1N4152
CR553	*152-0185-00	Silicon	Replaceable by 1N4152

[10]Matched pair with R488.

A5 STAIRCASE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q501	151-0224-00			Silicon	NPN	TO-18	2N3692
Q502	151-0224-00			Silicon	NPN	TO-18	2N3692
Q503	151-0224-00			Silicon	NPN	TO-18	2N3692
Q511	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q512	151-0224-00			Silicon	NPN	TO-18	2N3692
Q513	151-0224-00			Silicon	NPN	TO-18	2N3692
Q514	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q515	151-0220-00			Silicon	PNP	TO-18	2N4122
Q516	151-0225-00			Silicon	NPN	TO-18	2N3563
Q522	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q523	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q524	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q525	151-0225-00			Silicon	NPN	TO-18	2N3563
Q526	151-0225-00			Silicon	NPN	TO-18	2N3563
Q531	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q532	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q533	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q534	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q535	151-0225-00			Silicon	NPN	TO-18	2N3563
Q536	151-0225-00			Silicon	NPN	TO-18	2N3563
Q542	151-0225-00			Silicon	NPN	TO-18	2N3563
Q543	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q544	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q545	151-0225-00			Silicon	NPN	TO-18	2N3563
Q546	151-0225-00			Silicon	NPN	TO-18	2N3563
Q553	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q555	151-0225-00			Silicon	NPN	TO-18	2N3563

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R501	321-0431-00			301 kΩ	1/8 W	Prec	1%
R502	321-0337-00			31.6 kΩ	1/8 W	Prec	1%
R504	321-0680-00			35.3 kΩ	1/8 W	Prec	1/2%
R505	315-0102-00			1 kΩ	1/4 W		5%
R512	315-0103-00			10 kΩ	1/4 W		5%
R514	315-0101-00			100 kΩ	1/4 W		5%
R515	315-0101-00			100 kΩ	1/4 W		5%
R521	315-0333-00			33 kΩ	1/4 W		5%
R522	315-0152-00			1.5 kΩ	1/4 W		5%
R523	315-0471-00			470 Ω	1/4 W		5%

A5 STAIRCASE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R524	315-0101-00			100 Ω	1/4 W		5%
R525	315-0101-00			100 Ω	1/4 W		5%
R531	315-0101-00			100 Ω	1/4 W		5%
R532	315-0101-00			100 Ω	1/4 W		5%
R533	315-0101-00			100 Ω	1/4 W		5%
R534	315-0101-00			100 Ω	1/4 W		5%
R535	315-0101-00			100 Ω	1/4 W		5%
R541	315-0101-00			100 Ω	1/4 W		5%
R542	315-0362-00			3.6 kΩ	1/4 W		5%
R543	315-0681-00			680 Ω	1/4 W		5%
R544	315-0101-00			100 Ω	1/4 W		5%
R545	321-0261-01			5.23 kΩ	1/8 W	Prec	1/2%
R546	315-0101-00			100 Ω	1/4 W		5%
R547	315-0272-00			2.7 kΩ	1/4 W		5%
R548	315-0202-00			2 kΩ	1/4 W		5%
R549	315-0152-00			1.5 kΩ	1/4 W		5%
R551	321-0326-00			24.3 kΩ	1/8 W	Prec	1%
R552	321-0356-00			49.9 kΩ	1/8 W	Prec	1%
R553	321-0327-00			24.9 kΩ	1/8 W	Prec	1%
R554	321-0327-00			24.9 kΩ	1/8 W	Prec	1%
R555	321-0327-00			24.9 kΩ	1/8 W	Prec	1%
R556	321-0327-00			24.9 kΩ	1/8 W	Prec	1%
R557	321-0295-00			11.5 kΩ	1/8 W	Prec	1%
R558	321-0356-00			49.9 kΩ	1/8 W	Prec	1%
R559	315-0102-00			1 kΩ	1/4 W		5%
R560	315-0102-00			1 kΩ	1/4 W		5%
R561	311-0883-00			50 kΩ, Var			
R562	311-0836-00			5 kΩ, Var			
R563	311-0953-00			2.5 kΩ, Var			
R564	311-0953-00			2.5 kΩ, Var			
R565	311-0953-00			2.5 kΩ, Var			
R566	311-0953-00			2.5 kΩ, Var			
R567	311-0953-00			2.5 kΩ, Var			
R568	311-0836-00			5 kΩ, Var			
				Integrated Circuits			
U507	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U508	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U509	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U517	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			
U518	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914			

A5 STAIRCASE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Integrated Circuits (cont)
U519	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U537	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U538	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U539	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U547	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U548	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U557	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U558	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914

A6 LINE TIMING Circuit Board Assembly

*670-1322-00 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Value	Type	Voltage	Tolerance
C601	283-0032-00	470 pF	Cer	500 V	5%
C602	283-0032-00	470 pF	Cer	500 V	5%
C605	283-0032-00	470 pF	Cer	500 V	5%
C620	283-0149-00	25 pF	Cer	200 V	2%
C621	283-0059-00	1 μF	Cer	25 V	+80% —20%
C622	283-0594-00	0.001 μF	Mica	100 V	1%
C641	283-0077-00	330 pF	Cer	500 V	5%
C643	283-0032-00	470 pF	Cer	500 V	5%
C649	283-0065-00	0.001 μF	Cer	100 V	5%
C651	283-0077-00	330 pF	Cer	500 V	5%
C661	283-0077-00	330 pF	Cer	500 V	5%
C662	283-0593-00	0.01 μF	Mica	100 V	1%
C669	283-0622-00	450 pF	Mica	300 V	1%
C671	283-0077-00	330 pF	Cer	500 V	5%
C674	283-0004-00	0.02 μF	Cer	150 V	
C676	283-0003-00	0.01 μF	Cer	150 V	
C681	283-0077-00	330 pF	Cer	500 V	5%
C691	283-0077-00	330 pF	Cer	500 V	5%
C697	283-0004-00	0.02 μF	Cer	150 V	
C698	283-0004-00	0.02 μF	Cer	150 V	

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Capacitors (cont)

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C6210	283-0004-00			0.02 μF	Cer	150 V	
C6442	283-0083-00			0.0047 μF	Cer	500 V	5%
C6444	283-0032-00			470 pF	Cer	500 V	5%
C6540	283-0065-00			0.001 μF	Cer	100 V	5%
C6640	283-0065-00			0.001 μF	Cer	100 V	5%
C6662	283-0065-00			0.001 μF	Cer	100 V	5%
C6740	283-0004-00			0.02 μF	Cer	150 V	
C6774	283-0004-00			0.02 μF	Cer	150 V	
C6834	283-0095-00			56 pF	Cer	200 V	10%
C6836	283-0004-00			0.02 μF	Cer	150 V	
C6840	283-0004-00			0.02 μF	Cer	150 V	

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
CR622	*152-0185-00			Silicon	Replaceable by 1N4152
CR643	*152-0269-00			Silicon	Volt. var cap. Tek Spec
CR645	152-0008-00			Germanium	
CR646	*152-0185-00			Silicon	Replaceable by 1N4152
CR648	*152-0185-00			Silicon	Replaceable by 1N4152
CR654	*152-0185-00			Silicon	Replaceable by 1N4152
CR664	*152-0185-00			Silicon	Replaceable by 1N4152
CR676	*152-0185-00			Silicon	Replaceable by 1N4152
CR677	*152-0185-00			Silicon	Replaceable by 1N4152
CR697	*152-0185-00			Silicon	Replaceable by 1N4152
CR698	*152-0185-00			Silicon	Replaceable by 1N4152
CR6220	*152-0185-00			Silicon	Replaceable by 1N4152
CR6471	*152-0185-00			Silicon	Replaceable by 1N4152
CR6662	*152-0185-00			Silicon	Replaceable by 1N4152
CR6732	*152-0185-00			Silicon	Replaceable by 1N4152
CR6750	*152-0185-00			Silicon	Replaceable by 1N4152
CR6770	*152-0185-00			Silicon	Replaceable by 1N4152
VR666	152-0127-00			Zener	1N755A 400 mW, 7.5 V, 5%

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q610	151-0225-00			Silicon	NPN	TO-18	2N3563
Q621	151-0224-00			Silicon	NPN	TO-18	2N3692
Q622	151-0224-00			Silicon	NPN	TO-18	2N3692
Q642	151-0224-00			Silicon	NPN	TO-18	2N3692
Q643	151-0220-00			Silicon	PNP	TO-18	2N4122

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Transistors (cont)

Q644	151-0220-00			Silicon	PNP	TO-18 2N4122
Q645	151-0220-00			Silicon	PNP	TO-18 2N4122
Q646	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521
Q647	151-0224-00			Silicon	NPN	TO-18 2N3692
Q648	151-0224-00			Silicon	NPN	TO-18 2N3692
Q649	151-0220-00			Silicon	PNP	TO-18 2N4122
Q652	151-0224-00			Silicon	NPN	TO-18 2N3692
Q662	151-0224-00			Silicon	NPN	TO-18 2N3692
Q666	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521
Q667	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521
Q668	151-0220-00			Silicon	PNP	TO-18 2N4122
Q669	151-0223-00			Silicon	NPN	TO-18 2N4275
Q672	151-0224-00			Silicon	NPN	TO-18 2N3692
Q673	*151-1041-00			Silicon	FET	TO-71 N channel, dual, Tek Spec
Q674	151-0190-00			Silicon	NPN	TO-92 2N3904
Q675	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521
Q676	*151-0219-00			Silicon	PNP	TO-18 Replaceable by 2N4250
Q677	*151-0219-00			Silicon	PNP	TO-18 Replaceable by 2N4250
Q682	151-0224-00			Silicon	NPN	TO-18 2N3692
Q683	151-0220-00			Silicon	PNP	TO-18 2N4122
Q684	151-0220-00			Silicon	PNP	TO-18 2N4122
Q691	151-0224-00			Silicon	NPN	TO-18 2N3692
Q692	151-0224-00			Silicon	NPN	TO-18 2N3692
Q693	151-0220-00			Silicon	PNP	TO-18 2N4122
Q694	151-0220-00			Silicon	PNP	TO-18 2N4122
Q697	151-0224-00			Silicon	NPN	TO-18 2N3692
Q698	151-0224-00			Silicon	NPN	TO-18 2N3692

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R601	315-0243-00			24 kΩ	1/4 W		5%
R602	315-0202-00			2 kΩ	1/4 W		5%
R605	315-0202-00			2 kΩ	1/4 W		5%
R610	315-0222-00			2.2 kΩ	1/4 W		5%
R621	315-0103-00			10 kΩ	1/4 W		5%
R622	321-0316-00			19.1 kΩ	1/8 W	Prec	1%
R641	311-0704-00			500 Ω, Var			
R642	315-0222-00			2.2 kΩ	1/4 W		5%
R643	315-0153-00			15 kΩ	1/4 W		5%
R644	315-0121-00			120 Ω	1/4 W		5%

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R645	315-0331-00			330 Ω	¼ W		5%
R647	315-0182-00			1.8 kΩ	¼ W		5%
R648	315-0103-00			10 kΩ	¼ W		5%
R649	315-0272-00			2.7 kΩ	¼ W		5%
R651	311-0704-00			500 Ω, Var			
R652	315-0222-00			2.2 kΩ	¼ W		5%
R661	311-0704-00			500 Ω, Var			
R662	315-0222-00			2.2 kΩ	¼ W		5%
R666	321-0231-00			2.49 kΩ	⅛ W	Prec	1%
R667	321-0296-00			11.8 kΩ	⅛ W	Prec	1%
R668	315-0432-00			4.3 kΩ	¼ W		5%
R669	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R671	311-0704-00			500 Ω, Var			
R672	315-0222-00			2.2 kΩ	¼ W		5%
R674	315-0331-00			330 Ω	¼ W		5%
R675	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R676	315-0431-00			430 Ω	¼ W		5%
R682	315-0222-00			2.2 kΩ	¼ W		5%
R683	315-0101-00			100 Ω	¼ W		5%
R684	315-0912-00			9.1 kΩ	¼ W		5%
R691	311-0732-00			1 kΩ, Var			
R693	315-0101-00			100 Ω	¼ W		5%
R694	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R697	315-0474-00			470 kΩ	¼ W		5%
R698	315-0474-00			470 kΩ	¼ W		5%
R6010	315-0202-00			2 kΩ	¼ W		5%
R6100	315-0222-00			2.2 kΩ	¼ W		5%
R6210	315-0223-00			22 kΩ	¼ W		5%
R6220	315-0471-00			470 Ω	¼ W		5%
R6410	321-0284-00			8.87 kΩ	⅛ W	Prec	1%
R6412	321-0252-00			4.12 kΩ	⅛ W	Prec	1%
R6430	315-0753-00			75 kΩ	¼ W		5%
R6432	315-0753-00			75 kΩ	¼ W		5%
R6434	315-0105-00			1 MΩ	¼ W		5%
R6436	315-0124-00			120 kΩ	¼ W		5%
R6440	315-0300-00			30 Ω	¼ W		5%
R6442	315-0561-00			560 Ω	¼ W		5%
R6444	315-0124-00			120 kΩ	¼ W		5%
R6470	315-0102-00			1 kΩ	¼ W		5%
R6471	315-0102-00			1 kΩ	¼ W		5%

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R6480	315-0103-00			10 kΩ	1/4 W		5%
R6490	315-0272-00			2.7 kΩ	1/4 W		5%
R6510	321-0295-00			11.5 kΩ	1/8 W	Prec	1%
R6512	321-0252-00			4.12 kΩ	1/8 W	Prec	1%
R6540	321-0510-00			2 MΩ	1/8 W	Prec	1%
R6610	321-0298-00			12.4 kΩ	1/8 W	Prec	1%
R6612	321-0249-00			3.83 kΩ	1/8 W	Prec	1%
R6640	321-0510-00			2 MΩ	1/8 W	Prec	1%
R6660	321-0306-00			15 kΩ	1/8 W	Prec	1%
R6662	315-0473-00			47 kΩ	1/4 W		5%
R6664	315-0562-00			5.6 kΩ	1/4 W		5%
R6666	315-0102-00			1 kΩ	1/4 W		5%
R6670	321-0296-00			11.8 kΩ	1/8 W	Prec	1%
R6680	315-0202-00			2 kΩ	1/4 W		5%
R6681	315-0562-00			5.6 kΩ	1/4 W		5%
R6683	321-0281-00			8.25 kΩ	1/8 W	Prec	1%
R6690	321-0283-00			8.66 kΩ	1/8 W	Prec	1%
R6720	321-0314-00			18.2 kΩ	1/8 W	Prec	1%
R6722	321-0243-00			3.32 kΩ	1/8 W	Prec	1%
R6730	315-0363-00			36 kΩ	1/4 W		5%
R6731	315-0363-00			36 kΩ	1/4 W		5%
R6732	315-0752-00			7.5 kΩ	1/4 W		5%
R6740	315-0152-00			1.5 kΩ	1/4 W		5%
R6742	321-0251-00			4.02 kΩ	1/8 W	Prec	1%
R6750	315-0103-00			10 kΩ	1/4 W		5%
R6765	315-0511-00			510 Ω	1/4 W		5%
R6770	315-0102-00			1 kΩ	1/4 W		5%
R6772	321-0302-00			13.7 kΩ	1/8 W	Prec	1%
R6774	321-0251-00			4.02 kΩ	1/8 W	Prec	1%
R6820	321-0314-00			18.2 kΩ	1/8 W	Prec	1%
R6822	321-0241-00			3.16 kΩ	1/8 W	Prec	1%
R6824	321-0322-00			22.1 kΩ	1/8 W	Prec	1%
R6830	315-0682-00			6.8 kΩ	1/4 W		5%
R6832	315-0243-00			24 kΩ	1/4 W		5%
R6836	315-0106-00			10 MΩ	1/4 W		5%
R6840	315-0122-00			1.2 kΩ	1/4 W		5%
R6910	315-0222-00			2.2 kΩ	1/4 W		5%
R6912	321-0350-00			43.2 kΩ	1/8 W	Prec	1%
R6914	321-0235-00			2.74 kΩ	1/8 W	Prec	1%
R6940	321-0260-00			4.99 kΩ	1/8 W	Prec	1%

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Resistors (cont)		
R6970	315-0333-00			33 kΩ	1/4 W	5%
R6971	315-0153-00			15 kΩ	1/4 W	5%
R6975	315-0104-00			100 kΩ	1/4 W	5%
R6980	315-0333-00			33 kΩ	1/4 W	5%
R6981	315-0153-00			15 kΩ	1/4 W	5%
				Transformer		
T655	*120-0564-00			Toroid, 3 windings		
				Integrated Circuits		
U601	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U602	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U603	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U605	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U606	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U607	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U609	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U612	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U613	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U615	156-0010-00			Buffer-inverter. Replaceable by Fairchild μL9900		
U616	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U617	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U623	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U625	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U626	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		

A6 LINE TIMING Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Integrated Circuits (cont)
U627	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U629	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U633	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914
U636	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U637	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
U639	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923
				Crystal
Y643	158-0039-00			1.006993 MHz

A7 CROSS HATCH Circuit Board Assembly

*670-0957-00 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Value	Type	Voltage	Tolerance
C702	283-0104-00	200 pF	Cer	500 V	5%
C705	285-0703-00	0.1 μF	PTM	100 V	5%
C706	283-0083-00	0.0047 μF	Cer	500 V	5%
C712	283-0065-00	0.001 μF	Cer	100 V	5%
C716	283-0083-00	0.0047 μF	Cer	500 V	5%
C717	290-0134-00	22 μF	Elect.	15 V	
C718	290-0134-00	22 μF	Elect.	15 V	
C726	283-0032-00	470 pF	Cer	500 V	5%
C727	283-0003-00	0.01 μF	Cer	150 V	
C738	281-0613-00	10 pF	Cer	200 V	10%
C749	283-0080-00	0.022 μF	Cer	25 V	+80%—20%
C752	283-0026-00	0.2 μF	Cer	25 V	
C759	283-0632-00	87 pF	Mica	100 V	1%
C761	283-0594-00	0.001 μF	Mica	100 V	1%
C764	283-0047-00	270 pF	Cer	500 V	5%

A7 CROSS HATCH Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Capacitors (cont)			
C767	283-0596-00			528 pF	Mica	300 V	1%
C768	283-0602-00			53 pF	Mica	300 V	5%
C777	283-0026-00			0.2 μF	Cer	25 V	
C779	283-0610-00			220 pF	Mica	500 V	
C782	290-0134-00			22 μF	Elect.	15 V	
C783	283-0026-00			0.2 μF	Cer	25 V	
C785	283-0644-00			150 pF	Mica	500 V	1%
C792	283-0641-00			180 pF	Mica	100 V	1%
C795	283-0644-00			150 pF	Mica	500 V	1%
C796	283-0026-00			0.2 μF	Cer	25 V	
				Semiconductor Device, Diodes			
CR703	152-0008-00			Germanium			
CR749	*152-0185-00			Silicon	Replaceable by 1N4152		
CR762	*152-0185-00			Silicon	Replaceable by 1N4152		
CR781	*152-0185-00			Silicon	Replaceable by 1N4152		
CR784	*152-0185-00			Silicon	Replaceable by 1N4152		
CR787	*152-0185-00			Silicon	Replaceable by 1N4152		
CR791	*152-0185-00			Silicon	Replaceable by 1N4152		
CR794	*152-0185-00			Silicon	Replaceable by 1N4152		
				Inductors			
L768	*114-0222-00			2-6 μH, Var	Core 276-0568-00		
L769	*114-0222-00			2-6 μH, Var	Core 276-0568-00		
L791	114-0177-00			280-650 μH, Var	Core 276-0506-00		
				Transistors			
Q704	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q705	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q714	151-0190-00			Silicon	NPN	TO-92	2N3904
Q715	151-0190-00			Silicon	NPN	TO-92	2N3904
Q728	*151-0103-00			Silicon	NPN	TO-5	Replaceable by 2N2219
Q737	151-0220-00			Silicon	PNP	TO-18	2N4122
Q738	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q739	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q751	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q752	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250

A7 CROSS HATCH Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description				
				Transistors (cont)				
Q761	151-0190-00			Silicon	NPN	TO-92	2N3904	
Q762	151-0190-00			Silicon	NPN	TO-92	2N3904	
Q776	151-0190-00			Silicon	NPN	TO-92	2N3904	
Q777	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250	
Q783	151-0224-00			Silicon	NPN	TO-18	2N3692	
Q784	151-0220-00			Silicon	PNP	TO-18	2N4122	
Q786	151-0221-00			Silicon	PNP	TO-18	2N4258	
Q787	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515	
Q788	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515	
Q789	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515	
Q793	151-0225-00			Silicon	NPN	TO-18	2N3563	
Q794	151-0220-00			Silicon	PNP	TO-18	2N4122	
Q796	151-0190-00			Silicon	NPN	TO-92	2N3904	
Q797	*151-0198-00			Silicon	NPN	TO-92	Replaceable by MPS918	
Q798	151-0190-00			Silicon	NPN	TO-92	2N3904	
Q799	151-0190-00			Silicon	NPN	TO-92	2N3904	
				Resistors				
Resistors are fixed, composition, ±10% unless otherwise indicated.								
R702	315-0272-00			2.7 kΩ	1/4 W			5%
R703	321-0122-00			182 Ω	1/8 W	Prec		1%
R704	321-0225-00			2.15 kΩ	1/8 W	Prec		1%
R705	321-0300-00			13 kΩ	1/8 W	Prec		1%
R706	315-0432-00			4.3 kΩ	1/4 W			5%
R707	315-0101-00			100 Ω	1/4 W			5%
R709	308-0252-00			390 Ω	3 W	WW		5%
R711	315-0272-00			2.7 kΩ	1/4 W			5%
R713	315-0681-00			680 Ω	1/4 W			5%
R714	315-0102-00			1 kΩ	1/4 W			5%
R716	315-0562-00			5.6 kΩ	1/4 W			5%
R718	321-0085-00			75 Ω	1/8 W	Prec		1%
R719	321-0085-00			75 Ω	1/8 W	Prec		1%
R726	315-0202-00			2 kΩ	1/4 W			5%
R727	315-0431-00			430 Ω	1/4 W			5%
R728	315-0302-00			3 kΩ	1/4 W			5%
R729	311-0884-00			100 Ω, Var				
R736	315-0243-00			24 kΩ	1/4 W			5%
R738	321-0229-00			2.37 kΩ	1/8 W	Prec		1%
R739	321-0179-00			715 Ω	1/8 W	Prec		1%

A7 CROSS HATCH Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R744	315-0181-00			180 Ω	1/4 W		5%
R745	315-0162-00			1.6 kΩ	1/4 W		5%
R747	321-0210-00			1.5 kΩ	1/8 W	Prec	1%
R748	321-0147-00			323 Ω	1/8 W	Prec	1%
R749	321-0281-00			8.25 kΩ	1/8 W	Prec	1%
R751	321-0242-00			3.24 kΩ	1/8 W	Prec	1%
R752	321-0269-00			6.19 kΩ	1/8 W	Prec	1%
R753	315-0470-00			47 Ω	1/4 W		5%
R754	315-0222-00			2.2 kΩ	1/4 W		5%
R757	321-0210-00			1.5 kΩ	1/8 W	Prec	1%
R758	321-0256-00			4.53 kΩ	1/8 W	Prec	1%
R759	321-0108-00			130 Ω	1/8 W	Prec	1%
R760	321-0196-00			1.07 kΩ	1/8 W	Prec	1%
R761	315-0562-00			5.6 kΩ	1/4 W		5%
R762	315-0102-00			1 kΩ	1/4 W		5%
R763	315-0273-00			27 kΩ	1/4 W		5%
R764	315-0470-00			47 Ω	1/4 W		5%
R765	321-0310-00			16.5 kΩ	1/8 W	Prec	1%
R766	315-0102-00			1 kΩ	1/4 W		5%
R768	315-0470-00			47 Ω	1/4 W		5%
R770	315-0102-00			1 kΩ	1/4 W		5%
R771	315-0432-00			4.3 kΩ	1/4 W		5%
R772	315-0102-00			1 kΩ	1/4 W		5%
R773	315-0470-00			47 Ω	1/4 W		5%
R774	315-0472-00			4.7 kΩ	1/4 W		5%
R775	321-0270-00			6.34 kΩ	1/8 W	Prec	1%
R776	315-0102-00			1 kΩ	1/4 W		5%
R777	315-0470-00			47 Ω	1/4 W		5%
R778	315-0470-00			47 Ω	1/4 W		5%
R783	315-0202-00			2 kΩ	1/4 W		5%
R784	315-0471-00			470 Ω	1/4 W		5%
R787	321-0295-00			11.5 kΩ	1/8 W	Prec	1%
R788	321-0388-00			107 kΩ	1/8 W	Prec	1%
R789	321-0318-00			20 kΩ	1/8 W	Prec	1%
R791	315-0681-00			680 Ω	1/4 W		5%
R792	315-0102-00			1 kΩ	1/4 W		5%

A7 CROSS HATCH Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Resistors (cont)		
R793	315-0132-00			1.3 kΩ	¼ W	5%
R794	315-0132-00			1.3 kΩ	¼ W	5%
R795	315-0103-00			10 kΩ	¼ W	5%
R796	315-0162-00			1.6 kΩ	¼ W	5%
R697	315-0102-00			1 kΩ	¼ W	5%
				Integrated Circuits		
U711	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U712	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U721	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U722	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U723	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U724	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U725	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U731	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U732	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U733	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U734	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U735	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U741	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U742	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U743	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U744	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U745	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U775	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U785	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		

A8 POWER SUPPLY Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
	*670-0324-01			Complete Board			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C816	283-0000-00			0.001 μF	Cer	500 V	
C835	290-0162-00			22 μF	Elect.	35 V	
C850	283-0002-00			0.01 μF	Cer	500 V	
C855	290-0171-00			100 μF	Elect.	12 V	
C871	283-0026-00			0.2 μF	Cer	25 V	
C875	283-0000-00			0.001 μF	Cer	500 V	
C880	283-0010-00			0.05 μF	Cer	50 V	
C885	290-0312-00			47 μF	Elect.	35 V	10%

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
CR811	152-0066-00			Silicon	1N3194
CR812	152-0066-00			Silicon	1N3194
CR813	152-0066-00			Silicon	1N3194
CR814	152-0066-00			Silicon	1N3194
CR815	*152-0185-00			Silicon	Replaceable by 1N4152
CR841	152-0198-00			Silicon	MR1032A 200 V PIV
CR842	152-0198-00			Silicon	MR1032A 200 V PIV
CR861	152-0066-00			Silicon	1N3194
CR962	152-0066-00			Silicon	1N3194
VR870	152-0212-00			Zener	1N936 500 mW, 9 V, 5% TC

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q810	151-0224-00			Silicon	NPN	TO-18	2N3692
Q815	151-1005-00			Silicon	FET	TO-18	N channel, junction type
Q825	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q826	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q830	*151-0183-00			Silicon	NPN	TO-5	Selected from 2N2192
Q840	151-0224-00			Silicon	NPN	TO-18	2N3692
Q845	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q846	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q850	*151-0183-00			Silicon	NPN	TO-5	Selected from 2N2192
Q860	151-0224-00			Silicon	NPN	TO-18	2N3692

A8 POWER SUPPLY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Transistors (cont)			
Q875	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521	
Q876	*151-0192-00			Silicon	NPN	TO-92 Replaceable by MPS6521	
Q880	*151-0183-00			Silicon	NPN	TO-5 Selected from 2N2192	
				Resistors			

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R811	308-0245-00			0.6 Ω	2 W	WW	5%
R813	315-0101-00			100 Ω	1/4 W		5%
R816	315-0101-00			100 Ω	1/4 W		5%
R826	315-0222-00			2.2 kΩ	1/4 W		5%
R831	315-0222-00			2.2 kΩ	1/4 W		5%
R835	321-0219-00			1.87 kΩ	1/8 W	Prec	1%
R836	311-0827-00			250 Ω, Var			
R837	321-0237-00			2.87 kΩ	1/8 W	Prec	1%
R841	308-0244-00			0.3 Ω	2 W	WW	
R843	315-0101-00			100 Ω	1/4 W		5%
R846	315-0222-00			2.2 kΩ	1/4 W		5%
R848	315-0821-00			820 Ω	1/4 W		5%
R850	315-0390-00			39 Ω	1/4 W		5%
R852	315-0392-00			3.9 kΩ	1/4 W		5%
R855	321-0171-00			590 Ω	1/8 W	Prec	1%
R856	311-0827-00			250 Ω, Var			
R857	321-0237-00			2.87 kΩ	1/8 W	Prec	1%
R861	308-0245-00			0.6 Ω	2 W	WW	5%
R864	315-0101-00			100 Ω	1/4 W		5%
R870	321-0183-00			787 Ω	1/8 W	Prec	1%
R871	315-0471-00			470 Ω	1/4 W		5%
R872	315-0181-00			180 Ω	1/4 W		5%
R875	315-0122-00			1.2 kΩ	1/4 W		5%
R877	315-0621-00			620 Ω	1/4 W		5%
R879	315-0101-00			100 Ω	1/4 W		5%
R880	315-0150-00			15 Ω	1/4 W		5%
R885	321-0215-00			1.69 kΩ	1/8 W	Prec	1%
R886	311-0827-00			250 Ω, Var			
R887	321-0195-00			1.05 kΩ	1/8 W	Prec	1%
R889	315-0332-00			3.3 kΩ	1/4 W		5%

A9 OUTPUT AMPS Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
	*670-0308-00			Complete Board			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C903	283-0596-00			528 pF	Mica	300 V	1%
C904	283-0602-00			53 pF	Mica	300 V	5%
C905	283-0632-00			87 pF	Mica	100 V	1%
C906	283-0610-00			220 pF	Mica	500 V	
C912	283-0004-00			0.02 μF	Cer	150 V	
C914	290-0415-00			5.6 μF	Elect.	35 V	10%
C916	283-0004-00			0.02 μF	Cer	150 V	
C923	283-0596-00			528 pF	Mica	300 V	1%
C924	283-0602-00			53 pF	Mica	300 V	5%
C925	283-0632-00			87 pF	Mica	100 V	
C926	283-0610-00			220 pF	Mica	500 V	
C932	283-0004-00			0.02 μF	Cer	150 V	
C934	290-0415-00			5.6 μF	Elect.	35 V	10%
C936	283-0004-00			0.02 μF	Cer	150 V	
C943	283-0596-00			528 pF	Mica	300 V	1%
C944	283-0602-00			53 pF	Mica	300 V	5%
C945	283-0632-00			87 pF	Mica	100 V	1%
C946	283-0610-00			220 pF	Cer	500 V	
C952	283-0004-00			0.02 μF	Cer	150 V	
C954	290-0415-00			5.6 μF	Elect.	35 V	10%
C956	283-0004-00			0.02 μF	Cer	150 V	
C963	283-0596-00			528 pF	Mica	300 V	
C964	283-0602-00			53 pF	Mica	300 V	1%
C965	283-0632-00			87 pF	Mica	100 V	1%
C966	283-0610-00			220 pF	Mica	500 V	
C972	283-0004-00			0.02 μF	Cer	150 V	
C974	290-0415-00			5.6 μF	Elect.	35 V	10%
C976	283-0004-00			0.02 μF	Cer	150 V	
C981	290-0296-00			100 μF	Elect.	20 V	
C982	290-0409-00			1000 μF	Elect.	25 V	+75%—10%
C983	283-0596-00			528 pF	Mica	300 V	1%
C984	283-0602-00			53 pF	Mica	300 V	5%
C985	283-0632-00			87 pF	Mica	100 V	1%
C986	283-0610-00			220 pF	Mica	500 V	
C989	290-0134-00			22 μF	Elect.	15 V	
C992	283-0004-00			0.02 μF	Cer	150 V	
C994	290-0415-00			5.6 μF	Elect.	35 V	10%
C996	283-0004-00			0.02 μF	Cer	150 V	

A9 OUTPUT AMPS Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Semiconductor Device, Diodes
CR906	*152-0185-00			Silicon Replaceable by 1N4152
CR926	*152-0185-00			Silicon Replaceable by 1N4152
CR946	*152-0185-00			Silicon Replaceable by 1N4152
CR966	*152-0185-00			Silicon Replaceable by 1N4152
CR986	*152-0185-00			Silicon Replaceable by 1N4152
				Inductors
L904	*114-0222-00			2-6 μH, Var Core 276-0568-00
L905	*114-0222-00			2-6 μH, Var Core 276-0568-00
L924	*114-0222-00			2-6 μH, Var Core 276-0568-00
L925	*114-0222-00			2-6 μH, Var Core 276-0568-00
L944	*114-0222-00			2-6 μH, Var Core 276-0568-00
L945	*114-0222-00			2-6 μH, Var Core 276-0568-00
L964	*114-0222-00			2-6 μH, Var Core 276-0568-00
L965	*114-0222-00			2-6 μH, Var Core 276-0568-00
L984	*114-0222-00			2-6 μH, Var Core 276-0568-00
L985	*114-0222-00			2-6 μH, Var Core 276-0568-00
				Transistors
Q900	151-0220-00			Silicon PNP TO-18 2N4122
Q902	151-0220-00			Silicon PNP TO-18 2N4122
Q910	151-0220-00			Silicon PNP TO-18 2N4122
Q912	151-0221-00			Silicon PNP TO-18 2N4258
Q914	151-0190-00			Silicon NPN TO-92 2N3904
Q916	151-0164-00			Silicon PNP TO-5 2N3702
Q920	151-0220-00			Silicon PNP TO-18 2N4122
Q922	151-0220-00			Silicon PNP TO-18 2N4122
Q930	151-0220-00			Silicon PNP TO-18 2N4122
Q932	151-0221-00			Silicon PNP TO-18 2N4258
Q934	151-0190-00			Silicon NPN TO-92 2N3904
Q936	151-0164-00			Silicon PNP TO-5 2N3702
Q940	151-0220-00			Silicon PNP TO-18 2N4122
Q942	151-0220-00			Silicon PNP TO-18 2N4122
Q950	151-0220-00			Silicon PNP TO-18 2N4122
Q952	151-0221-00			Silicon PNP TO-18 2N4258
Q954	151-0190-00			Silicon NPN TO-92 2N3904
Q956	151-0164-00			Silicon PNP TO-5 2N3702
Q960	151-0220-00			Silicon PNP TO-18 2N4122
Q962	151-0220-00			Silicon PNP TO-18 2N4122

A9 OUTPUT AMPS Circuit Board Assembly (cont)

Transistors (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
Q964	151-0190-00			Silicon	NPN	TO-92	2N3904
Q970	151-0220-00			Silcon	PNP	TO-18	2N4122
Q972	151-0221-00			Silcon	PNP	TO-18	2N4258
Q974	151-0190-00			Silicon	NPN	TO-92	2N3904
Q976	151-0164-00			Silicon	PNP	TO-5	2N3702
Q978	151-0164-00			Silicon	PNP	TO-5	2N3702
Q980	151-0220-00			Silicon	PNP	TO-18	2N4122
Q982	151-0220-00			Silicon	PNP	TO-18	2N4122
Q990	151-0220-00			Silicon	PNP	TO-18	2N4122
Q992	151-0221-00			Silicon	PNP	TO-18	2N4258
Q994	151-0190-00			Silicon	NPN	TO-92	2N3904
Q996	151-0164-00			Silicon	PNP	TO-5	2N3702
Q998	151-0164-00			Silicon	PNP	TO-5	2N3702

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R900	315-0220-00			22 Ω	1/4 W		5%
R901	321-0222-00			2 kΩ	1/8 W	Prec	1%
R902	315-0101-00			100 Ω	1/4 W		5%
R905	321-0108-00			130 Ω	1/8 W	Prec	1%
R906	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R907	315-0103-00			10 kΩ	1/4 W		5%
R908	321-0275-00			7.15 kΩ	1/8 W	Prec	1%
R909	315-0202-00			2 kΩ	1/4 W		5%
R910	321-0222-00			2 kΩ	1/8 W	Prec	1%
R911	322-0085-00			75 Ω	1/4 W	Prec	1%
R912	315-0563-00			56 kΩ	1/4 W		5%
R913	315-0102-00			1 kΩ	1/4 W		5%
R914	315-0103-00			10 kΩ	1/4 W		5%
R916	315-0100-00			10 Ω	1/4 W		5%
R920	315-0220-00			22 Ω	1/4 W		5%
R921	321-0222-00			2 kΩ	1/8 W	Prec	1%
R922	315-0101-00			100 Ω	1/4 W		5%
R925	321-0108-00			130 Ω	1/8 W	Prec	1%
R926	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R927	315-0103-00			10 kΩ	1/4 W		5%
R928	321-0275-00			7.15 kΩ	1/8 W	Prec	1%
R929	315-0202-00			2 kΩ	1/4 W		5%
R930	321-0222-00			2 kΩ	1/8 W	Prec	1%
R931	322-0085-00			75 Ω	1/4 W	Prec	1%
R932	315-0563-00			56 kΩ	1/4 W		5%

A9 OUTPUT AMPS Circuit Board Assembly (cont)

Resistors (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R933	315-0102-00			1 kΩ	1/4 W		5%
R934	315-0103-00			10 kΩ	1/4 W		5%
R936	315-0100-00			10 Ω	1/4 W		5%
R940	315-0220-00			22 Ω	1/4 W		5%
R941	321-0222-00			2 kΩ	1/8 W	Prec	5%
R942	315-0101-00			100 Ω	1/4 W		1%
R944	301-0430-00			43 Ω	1/2 W		5%
R945	321-0108-00			130 Ω	1/8 W	Prec	1%
R946	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R947	315-0103-00			10 kΩ	1/4 W		5%
R948	321-0275-00			7.15 kΩ	1/8 W	Prec	1%
R949	315-0202-00			2 kΩ	1/4 W		5%
R950	321-0222-00			2 kΩ	1/8 W	Prec	1%
R951	322-0085-00			75 Ω	1/4 W	Prec	1%
R952	315-0563-00			56 kΩ	1/4 W		5%
R953	315-0102-00			1 kΩ	1/4 W		5%
R954	315-0103-00			10 kΩ	1/4 W		5%
R956	315-0100-00			10 Ω	1/4 W		5%
R960	315-0220-00			22 Ω	1/4 W		5%
R961	321-0222-00			2 kΩ	1/8 W	Prec	1%
R962	315-0101-00			100 Ω	1/4 W		5%
R964	321-0282-00			8.45 kΩ	1/8 W	Prec	1%
R965	321-0108-00			130 Ω	1/8 W	Prec	1%
R966	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R967	315-0103-00			10 kΩ	1/4 W		5%
R968	321-0275-00			7.15 kΩ	1/8 W	Prec	1%
R969	315-0202-00			2 kΩ	1/4 W		5%
R970	321-0222-00			2 kΩ	1/8 W	Prec	1%
R971	322-0085-00			75 Ω	1/4 W	Prec	1%
R972	315-0563-00			56 kΩ	1/4 W		5%
R973	315-0102-00			1 kΩ	1/4 W		5%
R974	315-0103-00			10 kΩ	1/4 W		5%
R975	307-0113-00			5.1 Ω	1/4 W		5%
R976	315-0100-00			10 Ω	1/4 W		5%
R977	307-0113-00			5.1 Ω	1/4 W		5%
R978	322-0085-00			75 Ω	1/4 W	Prec	1%
R979	315-0100-00			10 Ω	1/4 W		5%
R980	315-0220-00			22 Ω	1/4 W		5%
R981	321-0222-00			2 kΩ	1/8 W	Prec	1%
R982	315-0101-00			100 Ω	1/4 W		5%

A9 OUTPUT AMPS Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R983	321-0213-00			1.62 kΩ	1/8 W	Prec	1%
R984	315-0822-00			8.2 kΩ	1/4 W		5%
R985	321-0108-00			130 Ω	1/8 W	Prec	1%
R986	321-0260-00			4.99 kΩ	1/8 W	Prec	1%
R987	315-0103-00			10 kΩ	1/4 W		5%
R988	321-0275-00			7.15 kΩ	1/8 W	Prec	1%
R989	315-0202-00			2 kΩ	1/4 W		5%
R990	321-0222-00			2 kΩ	1/8 W	Prec	1%
R991	322-0085-00			75 Ω	1/4 W	Prec	1%
R992	315-0563-00			56 kΩ	1/4 W		5%
R993	315-0102-00			1 kΩ	1/4 W		1%
R994	315-0103-00			10 kΩ	1/4 W		5%
R995	307-0113-00			5.1 Ω	1/4 W		5%
R996	315-0100-00			10 Ω	1/4 W		5%
R997	307-0113-00			5.1 Ω	1/4 W		5%
R998	322-0085-00			75 Ω	1/4 W	Prec	1%
R999	315-0100-00			10 Ω	1/4 W		5%

A10 SUBCARRIER OUTPUT Circuit Board Assembly

*670-1318-00 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

C1149	283-0641-00			180 pF	Mica	100 V	1%
C1150	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C1152	283-0640-00			160 pF	Mica	100 V	1%
C1156	290-0134-00			22 μF	Elect.	15 V	
C1158	290-0134-00			22 μF	Elect.	15 V	
C1165	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C1186	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C1190	283-0641-00			180 pF	Mica	100 V	1%
C1192	283-0641-00			180 pF	Mica	100 V	1%

Semiconductor Device, Diodes

CR1105	*152-0185-00			Silicon	Replaceable by 1N4152
CR1110	*152-0185-00			Silicon	Replaceable by 1N4152
CR1115	*152-0185-00			Silicon	Replaceable by 1N4152

A10 SUBCARRIER OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Inductors

L1147	*114-0280-00			12-43 μH, Var	Core 276-0568-00
L1197	*114-0280-00			12-43 μH, Var	Core 276-0568-00

Transistors

Q1101	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q1105	151-0225-00			Silicon	NPN	TO-18	2N3563
Q1106	151-0225-00			Silicon	NPN	TO-18	2N3563
Q1111	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q1118	151-0224-00			Silicon	NPN	TO-18	2N3692
Q1138	151-0224-00			Silicon	NPN	TO-18	2N3692
Q1159	*151-0103-00			Silicon	NPN	TO-5	Replaceable by 2N2219
Q1168	151-0225-00			Silicon	NPN	TO-18	2N3563
Q1179	151-0225-00			Silicon	NPN	TO-18	2N3563

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1104	315-0242-00			2.4 kΩ	1/4 W		5%
R1105	321-0332-00			28 kΩ	1/8 W	Prec	1%
R1107	315-0102-00			1 kΩ	1/4 W		5%
R1110	315-0303-00			30 kΩ	1/4 W		5%
R1111	322-0157-00			422 Ω	1/4 W	Prec	1%
R1112	315-0302-00			3 kΩ	1/4 W		5%
R1114	315-0272-00			2.7 kΩ	1/4 W		5%
R1116	315-0203-00			20 kΩ	1/4 W		5%
R1119	315-0102-00			1 kΩ	1/4 W		5%
R1120	315-0102-00			1 kΩ	1/4 W		5%
R1121	321-0312-00			17.4 kΩ	1/8 W	Prec	1%
R1130	315-0470-00			47 Ω	1/4 W		5%
R1146	315-0470-00			47 Ω	1/4 W		5%
R1149	315-0470-00			47 Ω	1/4 W		5%
R1154	315-0181-00			180 Ω	1/4 W		5%
R1156	308-0243-00			240 Ω	3 W	WW	5%
R1157	315-0101-00			100 Ω	1/4 W		5%
R1158	322-0085-00			75 Ω	1/4 W	Prec	1%
R1159	322-0085-00			75 Ω	1/4 W	Prec	1%
R1160	321-0251-00			4.02 kΩ	1/8 W	Prec	1%

A10 SUBCARRIER OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Resistors (cont)

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R1162	321-0293-00			11 kΩ	⅛ W	Prec	1%
R1165	315-0182-00			1.8 kΩ	¼ W		5%
R1170	321-0277-00			7.5 kΩ	⅛ W	Prec	1%
R1176	321-0235-00			2.74 kΩ	⅛ W	Prec	1%
R1178	315-0332-00			3.3 kΩ	¼ W		5%
R1186	315-0470-00			47 Ω	¼ W		5%
R1192	321-0235-00			2.74 kΩ	⅛ W	Prec	1%

A11 SUBCARRIER OSC Circuit Board Assembly

*670-0310-00 Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C1122	283-0103-00			180 pF	Cer	500 V	5%
C1123	283-0103-00			180 pF	Cer	500 V	5%
C1124	281-0616-00			6.8 pF	Cer	200 V	
C1125	283-0028-00			0.0022 μF	Cer	50 V	
C1130	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C1131	283-0059-00			1 μF	Cer	25 V	+80%—20%
C1133	283-0178-00			0.1 μF	Cer	100 V	+80%—20%

Semiconductor Device, Diode

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
CR1122	*152-0269-00			Silicon	NPN	Volt. var cap.	Tek Spec

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
Q1126	*151-0198-00			Silicon	NPN	TO-92	Replaceable by MPS918
Q1127	*151-0198-00			Silicon	NPN	TO-92	Replaceable by MPS918
Q1133	*151-0195-00			Silicon	NPN	TO-92	Replaceable by MPS6515
Q1135	151-0232-00			Silicon	NPN	TO-78	Dual

A11 SUBCARRIER OSC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R1122	315-0124-00			120 kΩ	1/4 W		5%
R1123	315-0124-00			120 kΩ	1/4 W		5%
R1124	315-0753-00			75 kΩ	1/4 W		5%
R1125	315-0363-00			36 kΩ	1/4 W		5%
R1126	315-0153-00			15 kΩ	1/4 W		5%
R1127	315-0121-00			120 Ω	1/4 W		5%
R1128	315-0820-00			82 Ω	1/4 W		5%
R1129	315-0102-00			1 kΩ	1/4 W		5%
R1132	315-0271-00			270 Ω	1/4 W		5%
R1133	315-0332-00			3.3 kΩ	1/4 W		5%
R1138	321-0249-00			3.83 kΩ	1/8 W	Prec	1%
R1139	321-0237-00			2.87 kΩ	1/8 W	Prec	1%

Crystal

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
Y1126	158-0036-00			3.579545 MHz

A12 GEN LOCK Circuit Board Assembly

Tektronix Part No.	Description
*670-0999-00	Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C5002	283-0177-00			1 μF	Cer	25 V	+80%—20%
C5004	283-0256-00			130 pF	Cer	100 V	5%
C5006	283-0080-00			0.022 μF	Cer	25 V	+80%—20%
C5020	283-0004-00			0.02 μF	Cer	150 V	
C5023	290-0114-00			47 μF	Elect.	6 V	
C5036	290-0134-00			22 μF	Elect.	15 V	
C5060	283-0239-00			0.022 μF	Cer	50 V	10%
C5100	283-0003-00			0.01 μF	Cer	150 V	
C5126	283-0596-00			528 pF	Mica	300 V	1%
C5152	283-0004-00			0.02 μF	Cer	150 V	
C5162	283-0004-00			0.02 μF	Cer	150 V	
C5170	283-0004-00			0.02 μF	Cer	150 V	
C5174	283-0167-00			0.1 μF	Cer	200 V	10%
C5184	283-0110-00			0.005 μF	Cer	150 V	
C5190	283-0256-00			130 pF	Cer	100 V	5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Capacitors (cont)			
C5200	283-0167-00			0.1 μF	Cer	200 V	10%
C5220	283-0032-00			470 pF	Cer	500 V	5%
C5230	283-0618-00			130 pF	Mica	300 V	2%
C5235	283-0004-00			0.02 μF	Cer	150 V	
C5240	283-0618-00			130 pF	Mica	300 V	2%
C5242	283-0004-00			0.02 μF	Cer	150 V	
C5250	283-0004-00			0.02 μF	Cer	150 V	
C5262	283-0023-00			0.1 μF	Cer	10 V	
C5264	283-0032-00			470 pF	Cer	500 V	5%
C5266	283-0192-00			0.47 μF	Cer	3 V	+80%—20%
C5282	283-0119-00			2200 pF	Cer	200 V	5%
C5292	283-0023-00			0.1 μF	Cer	10 V	
C5294	283-0032-00			470 pF	Cer	500 V	5%
C5296	283-0192-00			0.47 μF	Cer	3 V	+80%—20%
C5312	283-0119-00			2200 pF	Cer	200 V	5%
C5347	283-0004-00			0.02 μF	Cer	150 V	
C5348	283-0004-00			0.02 μF	Cer	150 V	
C5377	283-0004-00			0.02 μF	Cer	150 V	
C5378	283-0004-00			0.02 μF	Cer	150 V	
C5380	283-0004-00			0.02 μF	Cer	150 V	
C5384	283-0004-00			0.02 μF	Cer	150 V	
C5390	283-0004-00			0.02 μF	Cer	150 V	
C5404	283-0017-00			1 μF	Cer	3 V	
C5420	283-0003-00			0.01 μF	Cer	150 V	
C5440	283-0003-00			0.01 μF	Cer	150 V	
C5470	290-0415-00			5.6 μF	Elect.	35 V	10%
C5542	290-0415-00			5.6 μF	Elect.	35 V	10%
C5600	290-0415-00			5.6 μF	Elect.	35 V	10%
C5610	283-0032-00			470 pF	Cer	500 V	5%
C5626	285-0702-00			0.033 μF	PTM	100 V	5%
C5630	283-0593-00			0.01 μF	Mica	100 V	1%
C5634	283-0047-00			270 pF	Cer	500 V	5%
C5640	283-0004-00			0.02 μF	Cer	150 V	
C5651	290-0415-00			5.6 μF	Elect.	35 V	10%
C5652	290-0415-00			5.6 μF	Elect.	35 V	10%
C5653	290-0415-00			5.6 μF	Elect.	35 V	10%
C5654	283-0111-00			0.1 μF	Cer	50 V	
C5660	283-0010-00			0.05 μF	Cer	50 V	
C5662	285-0702-00			0.033 μF	PTM	100 V	5%
C5710	290-0264-00			0.22 μF	Elect.	35 V	10%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Capacitors (cont)			
C5750	283-0003-00			0.01 μF	Cer	150 V	
C5763	283-0004-00			0.02 μF	Cer	150 V	
C5772	283-0032-00			470 pF	Cer	500 V	5%
C5782	283-0004-00			0.02 μF	Cer	150 V	
C5790	283-0004-00			0.02 μF	Cer	150 V	
C5820	283-0004-00			0.02 μF	Cer	150 V	
C5824	283-0003-00			0.01 μF	Cer	150 V	
C5845	283-0004-00			0.02 μF	Cer	150 V	
C5852	283-0004-00			0.02 μF	Cer	150 V	
				Semiconductor Device, Diodes			
CR5080	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5100	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5110	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5120	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5122	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5126	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5130	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5174	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5180	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5184	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5186	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5260	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5261	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5262	*152-0322-00			Silicon	Tek Spec		
CR5290	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5291	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5292	*152-0322-00			Silicon	Tek Spec		
CR5347	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5348	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5377	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5378	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5400	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5420	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5430	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5440	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5450	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5506	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5512	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5550	*152-0185-00			Silicon	Replaceable by 1N4152		
CR5620	*152-0185-00			Silicon	Replaceable by 1N4152		

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Semiconductor Device, Diodes (cont)
CR5812	*152-0185-00			Silicon Replaceable by 1N4152
CR5820	*152-0185-00			Silicon Replaceable by 1N4152
CR5822	*152-0185-00			Silicon Replaceable by 1N4152
				Inductors
L5004	108-0317-00			15 μH
L5190	*114-0303-00			6.5-23 μH, Var Core 276-0096-00
L5235	108-0317-00			15 μH
L5264	*108-0174-00			245 μH
L5294	*108-0174-00			245 μH
L5774	108-0226-00			100 μH
				Transistors
Q5010	151-0188-00			Silicon PNP TO-92 2N3906
Q5020	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5025	*151-0216-00			Silicon PNP TO-92 Replaceable by MPS6523
Q5030	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5035	151-0224-00			Silicon NPN TO-18 2N3692
Q5040	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5050	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5060	151-0190-00			Silicon NPN TO-92 2N3904
Q5070	151-0190-00			Silicon NPN TO-92 2N3904
Q5080	151-0188-00			Silicon PNP TO-92 2N3906
Q5090	151-0190-00			Silicon NPN TO-92 2N3904
Q5100	151-0188-00			Silicon PNP TO-92 2N3906
Q5110	151-0188-00			Silicon PNP TO-92 2N3906
Q5120	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5130	151-0220-00			Silicon PNP TO-18 2N4122
Q5140	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5150	151-0221-00			Silicon PNP TO-18 2N4258
Q5160	151-0221-00			Silicon PNP TO-18 2N4258
Q5170	151-0164-00			Silicon PNP TO-5 2N5447
Q5180	151-0221-00			Silicon PNP TO-18 2N4258
Q5190	151-0221-00			Silicon PNP TO-18 2N4258
Q5200	151-0190-00			Silicon NPN TO-92 2N3904
Q5210	151-0190-00			Silicon NPN TO-92 2N3904
Q5220	151-0220-00			Silicon PNP TO-18 2N4122
Q5230	151-0220-00			Silicon PNP TO-18 2N4122

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Eff Serial/Model	Disc No.	Description
				Transistors (cont)
Q5240	151-0220-00			Silicon PNP TO-18 2N4122
Q5250	151-0220-00			Silicon PNP TO-18 2N4122
Q5260	*151-0198-00			Silicon NPN TO-92 Replaceable by MPS918
Q5270	151-0188-00			Silicon PNP TO-92 2N3906
Q5280	151-0190-00			Silicon NPN TO-92 2N2904
Q5290	*151-0198-00			Silicon NPN TO-92 Replaceable by MPS918
Q5300	151-0188-00			Silicon PNP TO-92 2N3906
Q5310	151-0190-00			Silicon NPN TO-92 2N3904
Q5320	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5330	151-0224-00			Silicon NPN TO-18 2N3692
Q5340	151-0188-00			Silicon PNP TO-92 2N3906
Q5350	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5360	151-0224-00			Silicon NPN TO-18 2N3692
Q5370	151-0188-00			Silicon PNP TO-92 2N3906
Q5380	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5390	*151-0127-00			Silicon NPN TO-18 Selected from 2N2369
Q5400	*151-0216-00			Silicon PNP TO-92 Replaceable by MOT MPS6523
Q5410	151-0220-00			Silicon PNP TO-18 2N4122
Q5420	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5430	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5440	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5450	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5460	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5470	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5480	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5490	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5500	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5510	151-0164-00			Silicon PNP TO-5 2N5447
Q5520	151-0207-00			Silicon NPN TO-98 2N3415
Q5530	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5540	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5550	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5560	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS6521
Q5570	151-0224-00			Silicon NPN TO-18 2N3692
Q5580	151-0224-00			Silicon NPN TO-18 2N3692
Q5590	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5600	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5610	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5620	*151-0219-00			Silicon PNP TO-18 Replaceable by 2N4250
Q5630	151-0207-00			Silicon NPN TO-92 2N3415

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Transistors (cont)			
Q5640	151-0220-00			Silicon	PNP	TO-18	2N4122
Q5650	151-0224-00			Silicon	NPN	TO-18	2N3692
Q5660	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q5670	151-0220-00			Silicon	PNP	TO-18	2N4122
Q5680	151-0220-00			Silicon	PNP	TO-18	2N4122
Q5690	151-0224-00			Silicon	NPN	TO-18	2N3692
Q5700	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5710	151-0220-00			Silicon	PNP	TO-18	2N4122
Q5720	*151-0192-00			Silicon	NPN	TO-92	Replaceable by MPS6521
Q5730	151-0254-00			Silicon	NPN	TO-98	2N5308
Q5740	151-0164-00			Silicon	PNP	TO-5	2N5447
Q5750	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5760	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5770	151-0221-00			Silicon	PNP	TO-18	2N4258
Q5780	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5790	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5800	151-0164-00			Silicon	PNP	TO-5	2N5447
Q5810	151-0164-00			Silicon	PNP	TO-5	2N5447
Q5820	151-0164-00			Silicon	PNP	TO-5	2N5447
Q5830	*151-0219-00			Silicon	PNP	TO-18	Replaceable by 2N4250
Q5840	151-0190-00			Silicon	NPN	TO-92	2N3904
Q5850	151-0190-00			Silicon	NPN	TO-92	2N3904

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Value	Power	Tolerance
R5002	315-0430-00			43 Ω	¼ W	5%
R5004	315-0391-00			390 Ω	¼ W	5%
R5006	315-0102-00			1 kΩ	¼ W	5%
R5008	315-0103-00			10 kΩ	¼ W	5%
R5010	315-0153-00			15 kΩ	¼ W	5%
R5020	315-0241-00			240 Ω	¼ W	5%
R5022	315-0301-00			300 Ω	¼ W	5%
R5023	315-0100-00			10 Ω	¼ W	5%
R5025	315-0274-00			270 kΩ	¼ W	5%
R5030	315-0274-00			270 kΩ	¼ W	5%
R5035	315-0473-00			47 kΩ	¼ W	5%
R5036	315-0914-00			910 kΩ	¼ W	5%
R5054	315-0153-00			15 kΩ	¼ W	5%
R5056	315-0752-00			7.5 kΩ	¼ W	5%
R5080	315-0393-00			39 kΩ	¼ W	5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R5082	315-0562-00			5.6 kΩ	1/4 W		5%
R5090	315-0102-00			1 kΩ	1/4 W		5%
R5091	315-0152-00			1.5 kΩ	1/4 W		5%
R5100	315-0272-00			2.7 kΩ	1/4 W		5%
R5102	315-0561-00			560 Ω	1/4 W		5%
R5110	315-0153-00			15 kΩ	1/4 W		5%
R5112	315-0361-00			360 Ω	1/4 W		5%
R5114	315-0332-00			3.3 kΩ	1/4 W		5%
R5120	315-0102-00			1 kΩ	1/4 W		5%
R5122	315-0623-00			62 kΩ	1/4 W		5%
R5124	315-0152-00			1.5 kΩ	1/4 W		5%
R5126	315-0333-00			33 kΩ	1/4 W		5%
R5128	315-0362-00			3.6 kΩ	1/4 W		5%
R5129	315-0103-00			10 kΩ	1/4 W		5%
R5130	321-0346-00			39.2 kΩ	1/8 W	Prec	1%
R5132	315-0302-00			3 kΩ	1/4 W		5%
R5134	315-0153-00			15 kΩ	1/4 W		5%
R5140	315-0361-00			360 Ω	1/4 W		5%
R5142	315-0331-00			330 Ω	1/4 W		5%
R5150	315-0362-00			3.6 kΩ	1/4 W		5%
R5152	315-0102-00			1 kΩ	1/4 W		5%
R5160	315-0272-00			2.7 kΩ	1/4 W		5%
R5162	315-0241-00			240 Ω	1/4 W		5%
R5170	315-0472-00			4.7 kΩ	1/4 W		5%
R5172	315-0303-00			30 kΩ	1/4 W		5%
R5174	315-0271-00			270 Ω	1/4 W		5%
R5178	315-0203-00			20 kΩ	1/4 W		5%
R5180	315-0562-00			5.6 kΩ	1/4 W		5%
R5182	315-0153-00			15 kΩ	1/4 W		5%
R5184	315-0392-00			3.9 kΩ	1/4 W		5%
R5190	315-0272-00			2.7 kΩ	1/4 W		5%
R5194	315-0331-00			330 Ω	1/4 W		5%
R5196	315-0183-00			18 kΩ	1/4 W		5%
R5200	315-0472-00			4.7 kΩ	1/4 W		5%
R5202	315-0470-00			47 Ω	1/4 W		5%
R5204	315-0472-00			4.7 kΩ	1/4 W		5%
R5206	315-0361-00			360 Ω	1/4 W		5%
R5220	315-0330-00			33 Ω	1/4 W		5%
R5221	315-0202-00			2 kΩ	1/4 W		5%
R5222	315-0751-00			750 Ω	1/4 W		5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R5230	315-0101-00			100 Ω	1/4 W		5%
R5235	315-0331-00			330 Ω	1/4 W		5%
R5237	315-0101-00			100 Ω	1/4 W		5%
R5240	315-0101-00			100 Ω	1/4 W		5%
R5244	315-0202-00			2 kΩ	1/4 W		5%
R5250	315-0751-00			750 Ω	1/4 W		5%
R5260	315-0153-00			15 kΩ	1/4 W		5%
R5262	321-0181-00			750 Ω	1/8 W	Prec	1%
R5270	315-0103-00			10 kΩ	1/4 W		5%
R5272	315-0361-00			360 Ω	1/4 W		5%
R5274	321-0281-00			8.25 kΩ	1/8 W	Prec	1%
R5280	315-0242-00			2.4 kΩ	1/4 W		5%
R5282	315-0181-00			180 Ω	1/4 W		5%
R5290	315-0153-00			15 kΩ	1/4 W		5%
R5292	321-0181-00			750 Ω	1/8 W	Prec	1%
R5300	315-0103-00			10 kΩ	1/4 W		5%
R5302	315-0361-00			360 Ω	1/4 W		5%
R5304	321-0281-00			8.25 kΩ	1/8 W	Prec	1%
R5310	315-0242-00			2.4 kΩ	1/4 W		5%
R5312	315-0181-00			180 Ω	1/4 W		5%
R5320	315-0102-00			1 kΩ	1/4 W		5%
R5330	315-0152-00			1.5 kΩ	1/4 W		5%
R5332	315-0101-00			100 Ω	1/4 W		5%
R5340	321-0193-00			1 kΩ	1/8 W	Prec	1%
R5342	315-0101-00			100 Ω	1/4 W		5%
R5344	321-0201-00			1.21 kΩ	1/8 W	Prec	1%
R5346	315-0472-00			4.7 kΩ	1/4 W		5%
R5347	315-0153-00			15 kΩ	1/4 W		5%
R5348	315-0153-00			15 kΩ	1/4 W		5%
R5350	315-0102-00			1 kΩ	1/4 W		5%
R5360	315-0152-00			1.5 kΩ	1/4 W		5%
R5362	315-0101-00			100 Ω	1/4 W		5%
R5370	321-0193-00			1 kΩ	1/8 W	Prec	1%
R5372	315-0101-00			100 Ω	1/4 W		5%
R5374	321-0201-00			1.21 kΩ	1/8 W	Prec	1%
R5376	315-0472-00			4.7 kΩ	1/4 W		5%
R5377	315-0153-00			15 kΩ	1/4 W		5%
R5378	315-0153-00			15 kΩ	1/4 W		5%
R5380	315-0201-00			200 Ω	1/4 W		5%
R5382	315-0151-00			150 Ω	1/4 W		5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R5384	315-0473-00			47 kΩ	¼ W		5%
R5390	315-0201-00			200 Ω	¼ W		5%
R5392	315-0151-00			150 Ω	¼ W		5%
R5400	315-0183-00			18 kΩ	¼ W		5%
R5402	315-0303-00			30 kΩ	¼ W		5%
R5404	315-0470-00			47 Ω	¼ W		5%
R5406	315-0303-00			30 kΩ	¼ W		5%
R510	315-0102-00			1 kΩ	¼ W		5%
R5420	315-0473-00			47 kΩ	¼ W		5%
R5422	321-0318-00			20 kΩ	⅛ W	Prec	1%
R5424	321-0335-00			30.1 kΩ	⅛ W	Prec	1%
R5430	321-0371-00			71.5 kΩ	⅛ W	Prec	1%
R5432	321-0331-00			27.4 kΩ	⅛ W	Prec	1%
R5434	321-0705-00			4.7 kΩ	⅛ W	Prec	1%
R5440	315-0473-00			47 kΩ	¼ W		5%
R5442	321-0318-00			20 kΩ	⅛ W	Prec	1%
R5444	321-0335-00			30.1 kΩ	⅛ W	Prec	1%
R5450	321-0371-00			71.5 kΩ	⅛ W	Prec	1%
R5452	321-0331-00			27.4 kΩ	⅛ W	Prec	1%
R5454	321-0705-00			41.7 kΩ	⅛ W	Prec	1%
R5456	315-0474-00			470 kΩ	¼ W		5%
R5460	315-0753-00			75 kΩ	¼ W		5%
R5462	315-0682-00			6.8 kΩ	¼ W		5%
R5470	315-0391-00			390 Ω	¼ W		5%
R5475	315-0203-00			20 kΩ	¼ W		5%
R5480	321-0220-00			1.91 kΩ	⅛ W	Prec	1%
R5482	321-0224-00			2.1 kΩ	⅛ W	Prec	1%
R5495	315-0392-00			3.9 kΩ	¼ W		5%
R5500	321-0319-00			20.5 kΩ	⅛ W	Prec	1%
R5502	315-0472-00			4.7 kΩ	¼ W		5%
R5504	321-0349-00			42.2 kΩ	⅛ W	Prec	1%
R5506	315-0103-00			10 kΩ	¼ W		5%
R5510	315-0202-00			2 kΩ	¼ W		5%
R5512	315-0333-00			33 kΩ	¼ W		5%
R5514	315-0473-00			47 kΩ	¼ W		5%
R5515	311-0836-00			5 kΩ, Var			5%
R5520	315-0202-00			2 kΩ	¼ W		5%
R5530	315-0103-00			10 kΩ	¼ W		5%
R5540	315-0393-00			39 kΩ	¼ W		5%
R5542	315-0123-00			12 kΩ	¼ W		5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R5544	315-0475-00			4.7 MΩ	1/4 W		5%
R5550	315-0103-00			10 kΩ	1/4 W		5%
R5551	315-0102-00			1 kΩ	1/4 W		5%
R5552	315-0751-00			750 Ω	1/4 W		5%
R5555	315-0473-00			47 kΩ	1/4 W		5%
R5560	316-0565-00			5.6 MΩ	1/4 W		
R5564	315-0104-00			100 kΩ	1/4 W		5%
R5570	315-0273-00			27 kΩ	1/4 W		5%
R5580	315-0752-00			7.5 kΩ	1/4 W		5%
R5590	315-0513-00			51 kΩ	1/4 W		5%
R5592	315-0512-00			5.1 kΩ	1/4 W		5%
R5594	315-0152-00			1.5 kΩ	1/4 W		5%
R5595	315-0392-00			3.9 kΩ	1/4 W		5%
R5600	315-0272-00			2.7 kΩ	1/4 W		5%
R5602	315-0474-00			470 kΩ	1/4 W		5%
R5610	315-0104-00			100 kΩ	1/4 W		5%
R5620	315-0103-00			10 kΩ	1/4 W		5%
R5622	321-0318-00			20 kΩ	1/8 W	Prec	1%
R5624	321-0408-00			174 kΩ	1/8 W	Prec	1%
R5626	315-0102-00			1 kΩ	1/4 W		5%
R5630	321-0253-00			4.22 kΩ	1/8 W	Prec	1%
R5632	315-0103-00			10 kΩ	1/4 W		5%
R5634	315-0753-00			75 kΩ	1/4 W		5%
R5640	315-0102-00			1 kΩ	1/4 W		5%
R5642	315-0202-00			2 kΩ	1/4 W		5%
R5650	315-0471-00			470 Ω	1/4 W		5%
R5660	315-0102-00			1 kΩ	1/4 W		5%
R5662	321-0221-00			1.96 kΩ	1/8 W	Prec	1%
R5670	315-0272-00			2.7 kΩ	1/4 W		5%
R5680	315-0102-00			1 kΩ	1/4 W		5%
R5690	315-0272-00			2.7 kΩ	1/4 W		5%
R5692	315-0472-00			4.7 kΩ	1/4 W		5%
R5694	315-0272-00			2.7 kΩ	1/4 W		5%
R5700	321-0435-00			332 kΩ	1/8 W	Prec	1%
R5702	315-0431-00			430 Ω	1/4 W		5%
R5710	315-0184-00			180 kΩ	1/4 W		5%
R5720	315-0272-00			2.7 kΩ	1/4 W		5%
R5722	315-0272-00			2.7 kΩ	1/4 W		5%
R5730	315-0752-00			7.5 kΩ	1/4 W		5%
R5732	315-0472-00			4.7 kΩ	1/4 W		5%

A12 GEN LOCK Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			Resistors (cont)			
R5734	315-0100-00			10 Ω	¼ W	5%
R5736	315-0272-00			2.7 kΩ	¼ W	5%
R5738	315-0182-00			1.8 kΩ	¼ W	5%
R5750	315-0470-00			47 Ω	¼ W	5%
R5752	315-0103-00			10 kΩ	¼ W	5%
R5754	315-0752-00			7.5 kΩ	¼ W	5%
R5760	315-0133-00			13 kΩ	¼ W	5%
R5762	315-0152-00			5 kΩ	¼ W	5%
R5763	315-0470-00			47 Ω	¼ W	5%
R5770	315-0432-00			4.3 kΩ	¼ W	5%
R5772	315-0301-00			300 Ω	¼ W	5%
R5774	315-0202-00			2 kΩ	¼ W	5%
R5780	315-0103-00			10 kΩ	¼ W	5%
R5782	315-0303-00			30 k	¼ W	5%
R5790	315-0222-00			2.2 kΩ	¼ W	5%
R5800	315-0753-00			75 kΩ	¼ W	5%
R5802	315-0154-00			150 kΩ	¼ W	5%
R5812	315-0752-00			7.5 kΩ	¼ W	5%
R5814	315-0272-00			2.7 kΩ	¼ W	5%
R5815	315-0511-00			510 Ω	¼ W	5%
R5822	315-0752-00			7.5 kΩ	¼ W	5%
R5824	315-0132-00			1.3 kΩ	¼ W	5%
R5830	315-0332-00			3.3 kΩ	¼ W	5%
R5840	315-0272-00			2.7 kΩ	¼ W	5%
R5845	315-0470-00			47 Ω	¼ W	5%
R5850	315-0203-00			20 kΩ	¼ W	5%
R5852	315-0621-00			620 Ω	¼ W	5%
			Integrated Circuits			
U5650	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U5660	156-0012-00			Clocked J-K flip-flop. Replaceable by Fairchild μL9923		
U5670	156-0012-00			Clocked J-K flip-flop Replaceable by Fairchild μL9923		
U5680	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		
U5700	156-0011-00			Medium power dual 2-input gate. Replaceable by Fairchild μL9914		

SECTION 9

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:

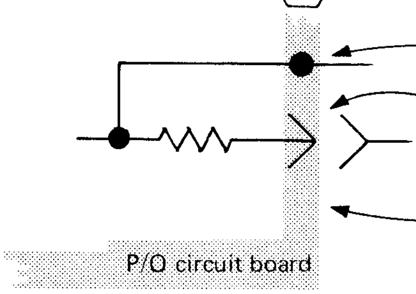

Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

3 Refer to diagram number indicated in diamond.

7 Refer to waveform number indicated in hexagon.



Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal

VOLTAGE AND WAVEFORM CONDITIONS

DC circuit voltages measured with a digital multimeter with an accuracy of 0.1%; input impedance is greater than 1 kMΩ on the 1.500 volt range and 10 MΩ on the higher ranges. AC voltages measured with a VOM having an accuracy of 3%. All voltages were measured with respect to chassis ground unless noted otherwise.

Waveforms shown are actual photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Each major division represents one cm. Test oscilloscope deflection factor and sweep rate conditions are noted adjacent to each waveform. DC coupling was used to obtain the DC levels that are recorded at the right side of each waveform. These DC levels are located with respect to the graticule line rather than to the waveform. To indicate time relationship between signals, the test oscilloscope was triggered externally, where possible. The triggering source is indicated on the individual diagrams.

Voltages and Waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances and internal calibration.

The test oscilloscope used for obtaining the waveform photographs had the following minimum characteristics: Deflection factor, 1 mV/cm to 1 V/cm (10 mV/cm to 10 V/cm with a 10X probe); frequency response, DC to 10 MHz; sweep rates, 0.1 μ/cm to 10 ms/cm.

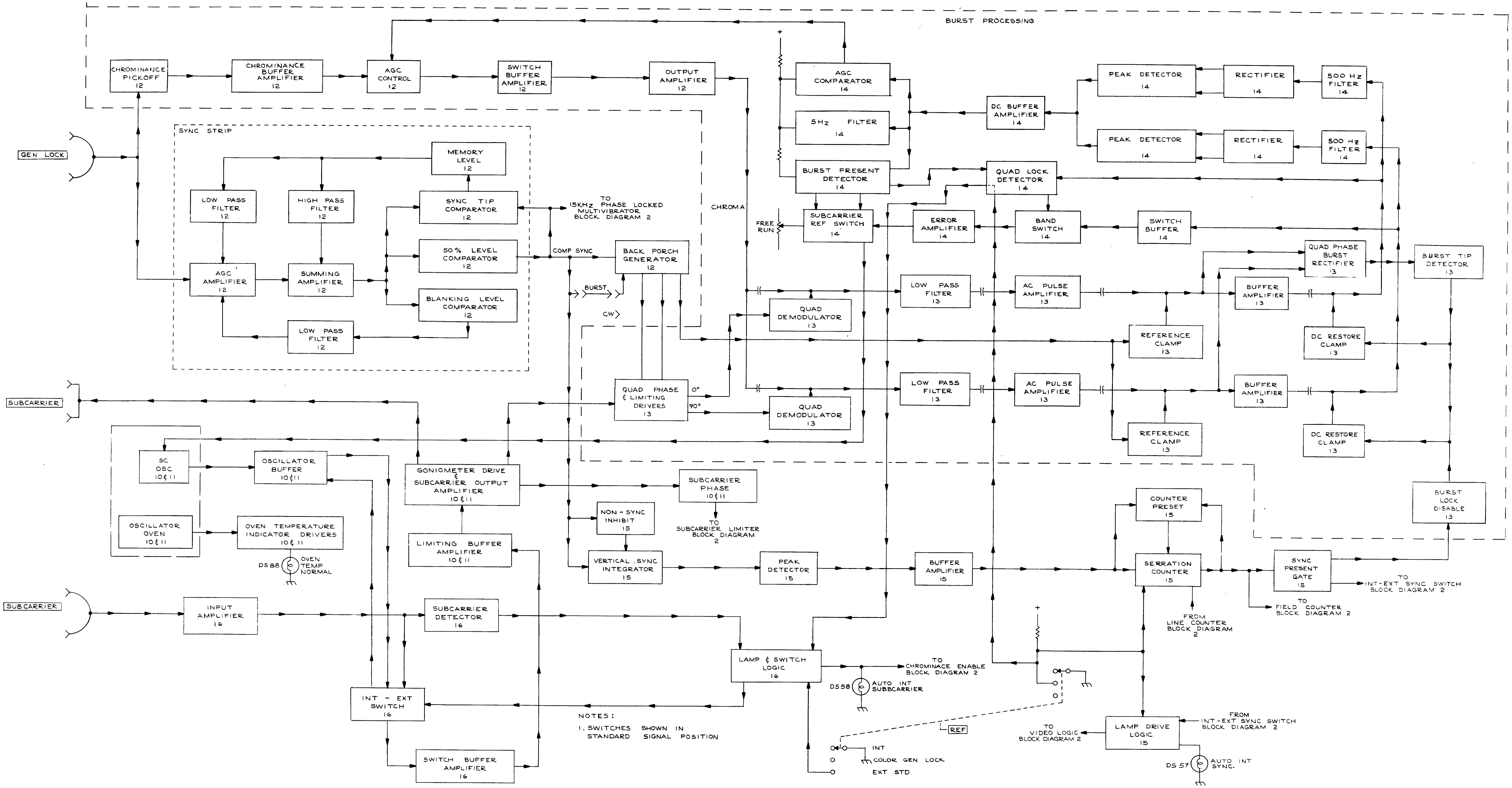
WARNING

"Ground lugs" are not always at ground potential. Check the diagram before using such connections as a ground for the multimeter, VOM or oscilloscope probe.

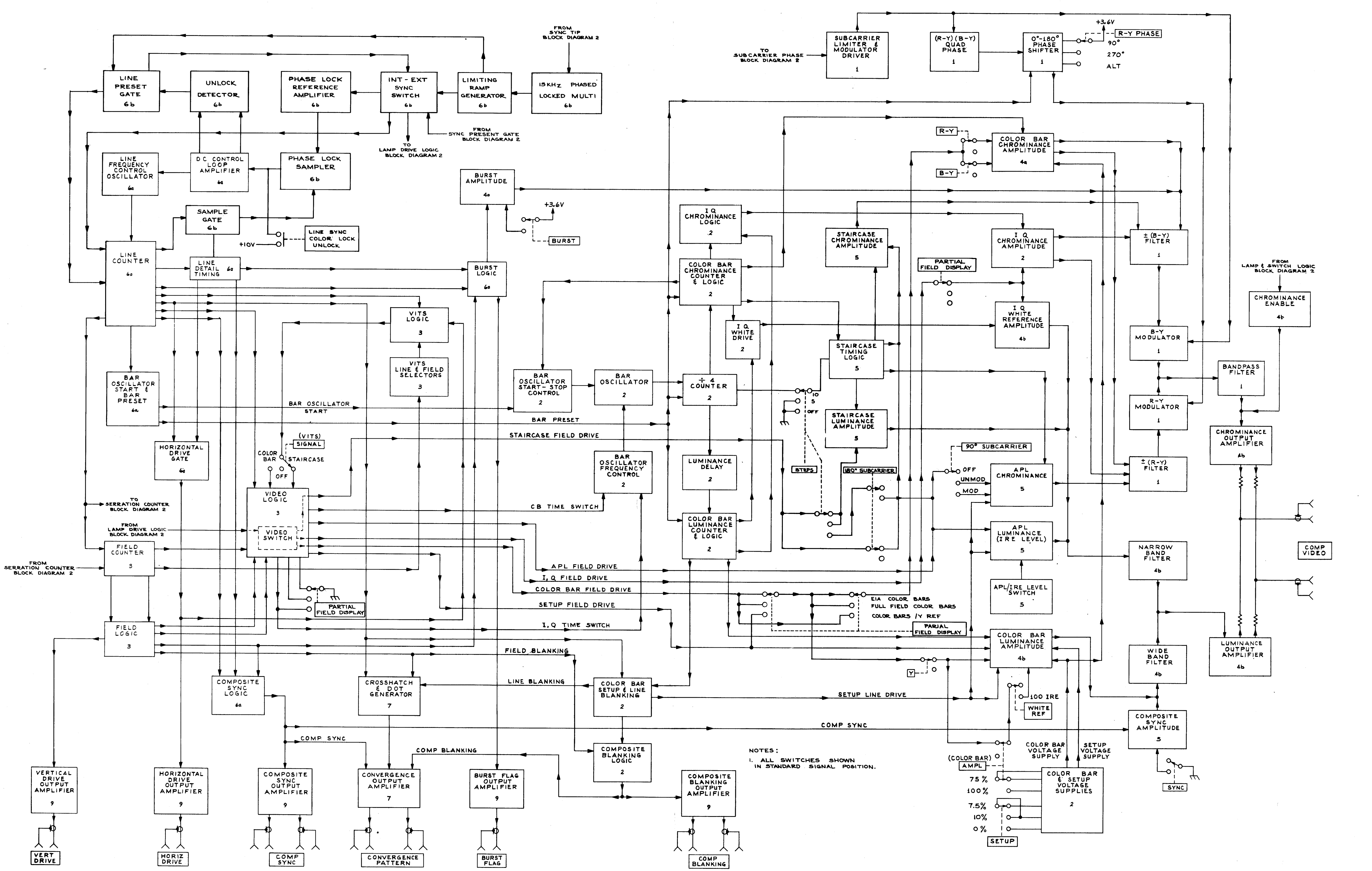
A Type 140 was used as an external signal source to provide composite video and subcarrier.

The 146 switches were set to the STANDARD SIGNAL position (except, as indicated on the individual diagrams). Other control settings are:

LINE	18
HORIZ POSITION	Centered
VERT POSITION	Centered
CHROMA PHASE	Centered
POWER	ON
Line Voltage	Design Center (115 VAC)

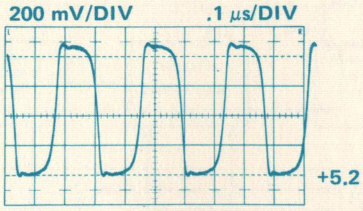

BURST PROCESSING
CHROMINANCE PICKOFF 12
CHROMINANCE BUFFER AMPLIFIER 12
AGC CONTROL 12
SWITCH BUFFER AMPLIFIER 12
OUTPUT AMPLIFIER 12
AGC COMPARATOR 14
5Hz FILTER 14
BURST PRESENT DETECTOR 14
DC BUFFER AMPLIFIER 14
PEAK DETECTOR 14
RECTIFIER 14
500 Hz FILTER 14
QUAD LOCK DETECTOR 14
GEN LOCK
SYNC STRIP
MEMORY LEVEL 12
LOW PASS FILTER 12
HIGH PASS FILTER 12
SYNC TIP COMPARATOR 12
TO 15KHz PHASE LOCKED MULTIVIBRATOR BLOCK DIAGRAM 2
CHROMA
FREE RUN
SUBCARRIER REF SWITCH 14
ERROR AMPLIFIER 14
BAND SWITCH 14
SWITCH BUFFER 14
AGC AMPLIFIER 12
SUMMING AMPLIFIER 12
50% LEVEL COMPARATOR 12
COMP SYNC
BACK PORCH GENERATOR 12
BLANKING LEVEL COMPARATOR 12
BURST
CW
QUAD PHASE BURST RECTIFIER 13
BURST TIP DETECTOR 13
LOW PASS FILTER 13
AC PULSE AMPLIFIER 13
BUFFER AMPLIFIER 13
QUAD DEMODULATOR 13
REFERENCE CLAMP 13
DC RESTORE CLAMP 13
SUBCARRIER
QUAD PHASE & LIMITING DRIVERS 13
0°
90°
SC OSC 10 & 11
OSCILLATOR BUFFER 10 & 11
GONIOMETER DRIVE & SUBCARRIER OUTPUT AMPLIFIER 10 & 11
SUBCARRIER PHASE 10 & 11
TO SUBCARRIER LIMITER BLOCK DIAGRAM 2
NON - SYNC INHIBIT 15
COUNTER PRESET 15
BURST LOCK DISABLE 13
OSCILLATOR OVEN 10 & 11
OVEN TEMPERATURE INDICATOR DRIVERS 10 & 11
DS88
OVEN TEMP NORMAL
LIMITING BUFFER AMPLIFIER 10 & 11
VERTICAL SYNC INTEGRATOR 15
PEAK DETECTOR 15
BUFFER AMPLIFIER 15
SERRATION COUNTER 15
SYNC PRESENT GATE 15
TO INT-EXT SYNC SWITCH BLOCK DIAGRAM 2
TO FIELD COUNTER BLOCK DIAGRAM 2
FROM LINE COUNTER BLOCK DIAGRAM 2
INPUT AMPLIFIER 16
SUBCARRIER DETECTOR 16
LAMP & SWITCH LOGIC 16
TO CHROMINACE ENABLE BLOCK DIAGRAM 2
DS58
AUTO INT SUBCARRIER
INT - EXT SWITCH 16
NOTES:
1. SWITCHES SHOWN IN STANDARD SIGNAL POSITION
REF
INT
COLOR GEN LOCK
EXT STD
TO VIDEO LOGIC BLOCK DIAGRAM 2
LAMP DRIVE LOGIC 15
FROM INT-EXT SYNC SWITCH BLOCK DIAGRAM 2
DS 57
AUTO INT SYNC.
SWITCH BUFFER AMPLIFIER 16

Ⓐ



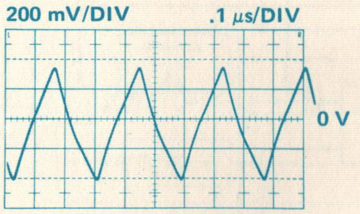
BLOCK DIAGRAM II

1



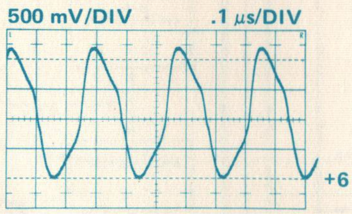
*

2



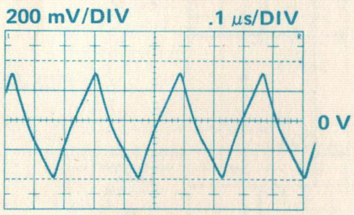
*

3



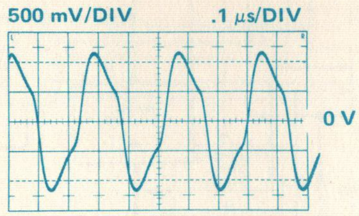
*

4



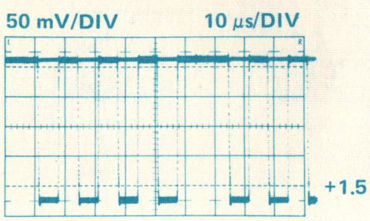
*

5



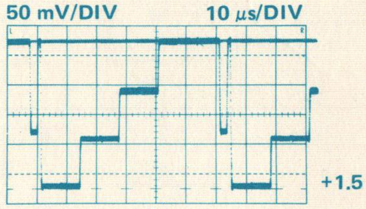
*

6



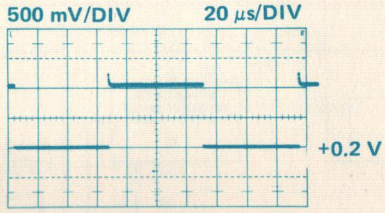
**

7



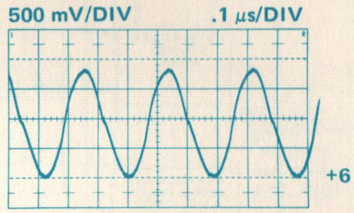
**

8



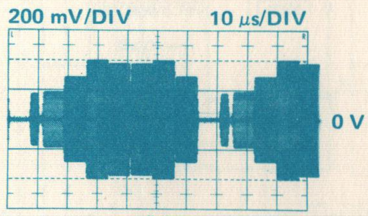
***

9



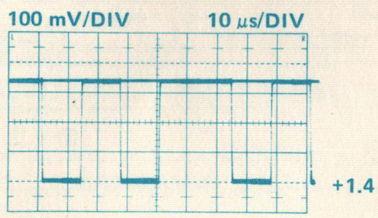
*

10



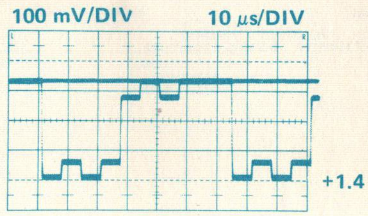
**

11



**

12



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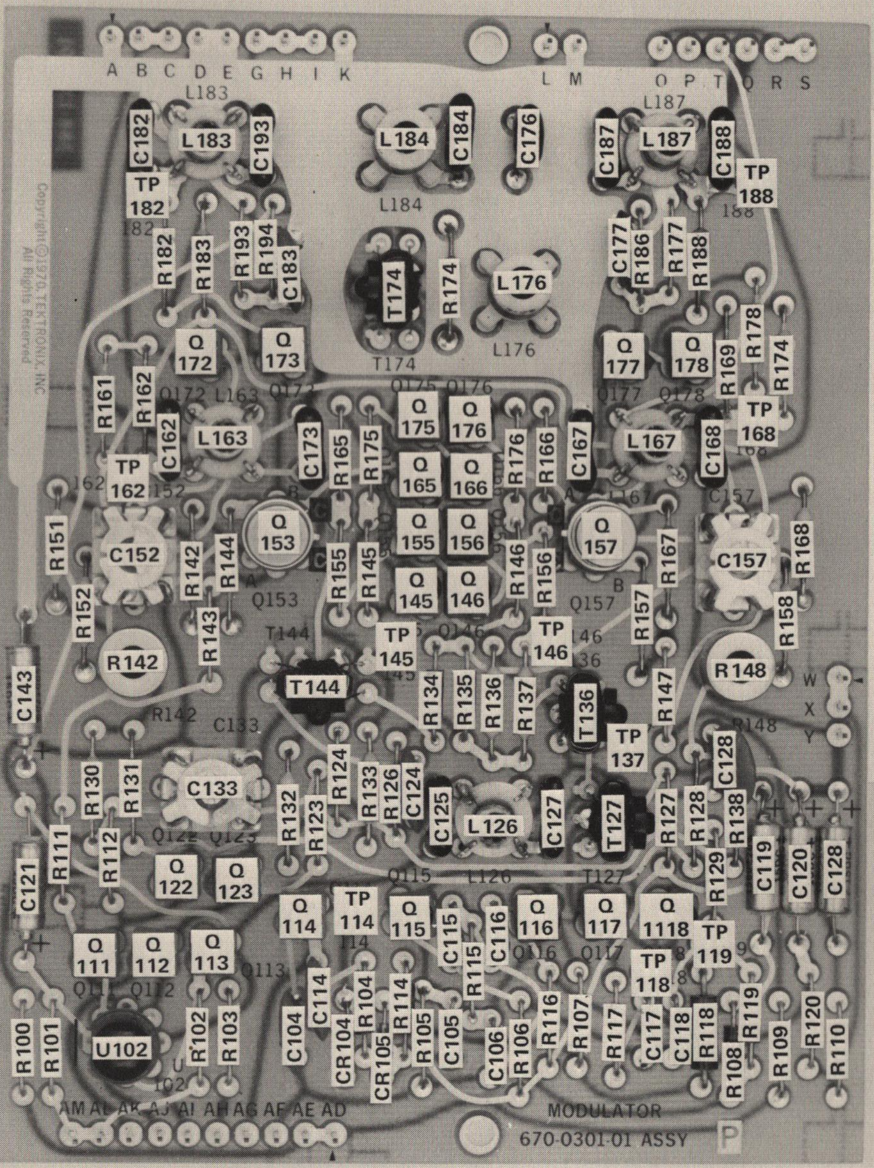
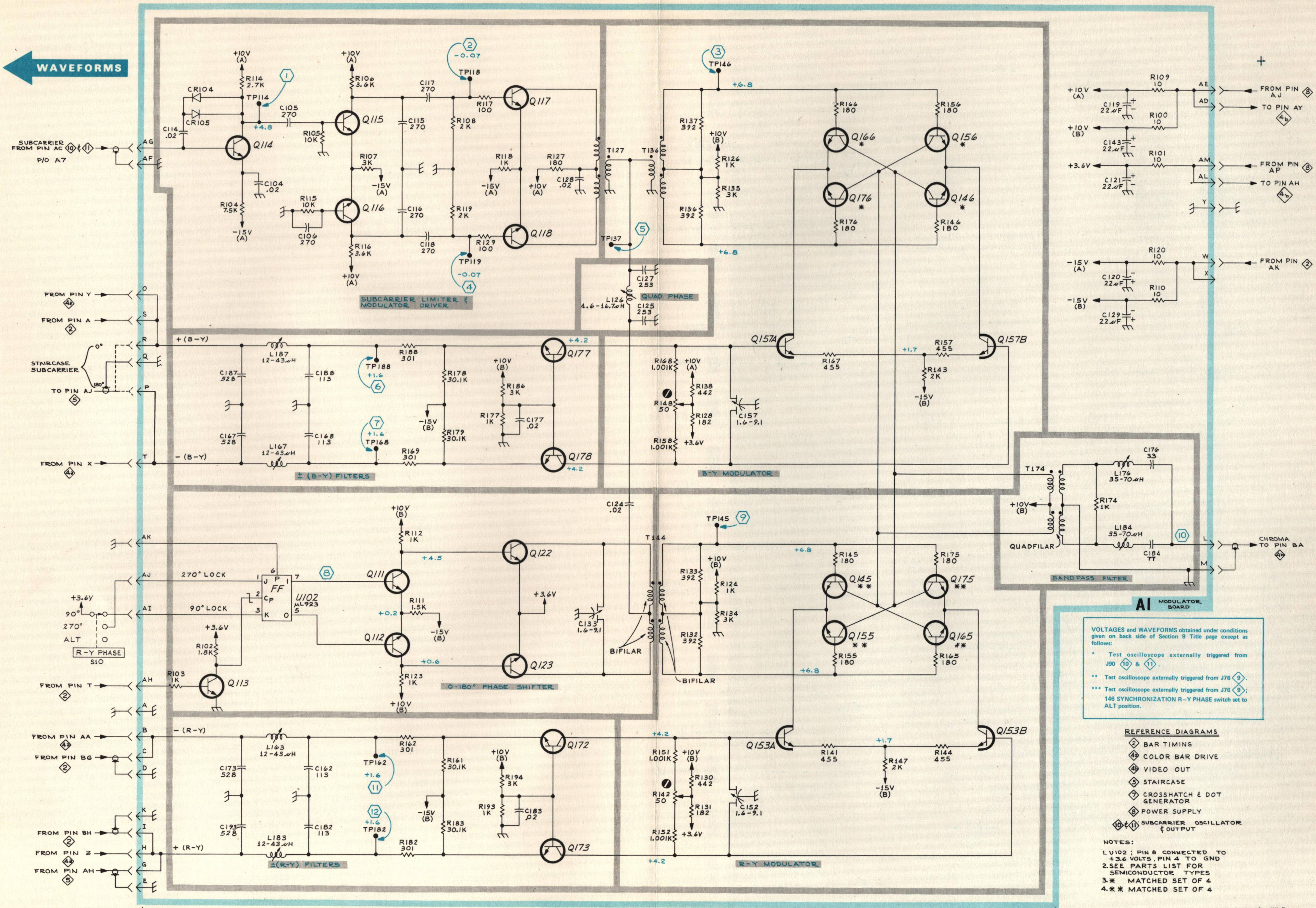


'A' blk
'B' brn on wht
'C' blu on wht coax
'D' Shield for 'C'
'E' Shield for 'G'
'G' grn on wht coax
'H' brn on wht
'I' yel on wht coax
'K' Shield for 'I'
'L' brn on wht coax
'M' Shield for 'L'
'O' brn on wht
'P' orn on wht coax
'T' brn on wht
'Q' Shield for 'P'
'S' red on wht
'W' blk on vio
'Y' blk
'AD' brn on red
'AE' brn on red
'AF' Shield for 'AD'
'AG' red on wht coax
'AH' brn-red on wht
'AI' gry on wht
'AJ' blk on wht
'AK' blk
'AL' blk on red
'AM' blk on red

Modulator A1



VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:

* Test oscilloscope externally triggered from J90 10 & 11.

** Test oscilloscope externally triggered from J76 9.

*** Test oscilloscope externally triggered from J76 9; 146 SYNCHRONIZATION R-Y PHASE switch set to ALT position.

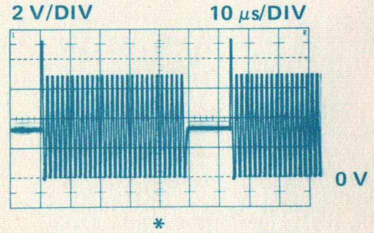
REFERENCE DIAGRAMS

2 BAR TIMING
4a COLOR BAR DRIVE
4b VIDEO OUT
5 STAIRCASE
7 CROSSHATCH & DOT GENERATOR
8 POWER SUPPLY
10 & 11 SUBCARRIER OSCILLATOR & OUTPUT

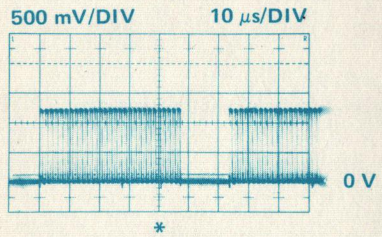
NOTES:
1. U102 ; PIN 8 CONNECTED TO +3.6 VOLTS, PIN 4 TO GND
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
3. * MATCHED SET OF 4
4. ** MATCHED SET OF 4

MODULATOR

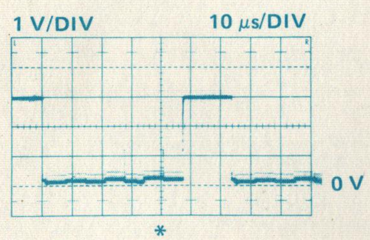
1



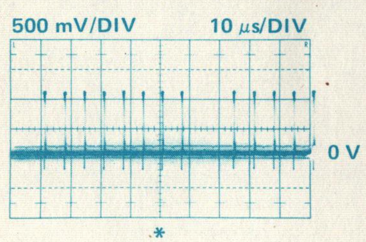
2



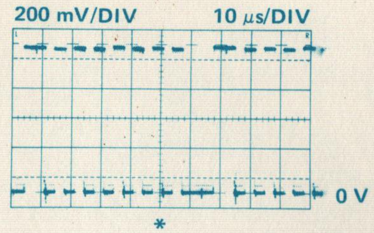
3



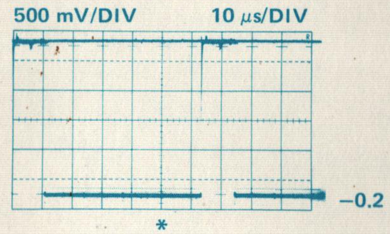
4



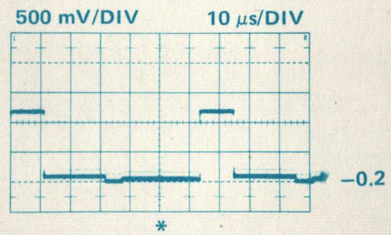
5



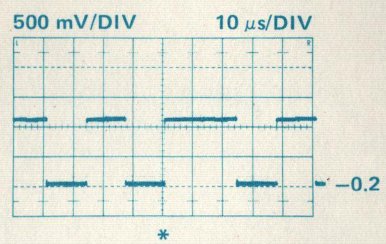
6



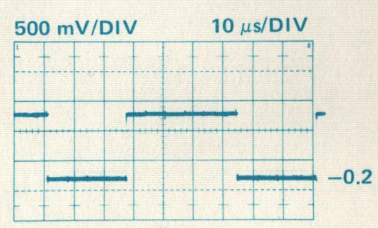
7



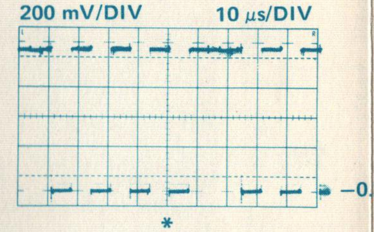
8



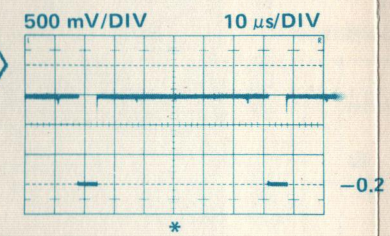
9



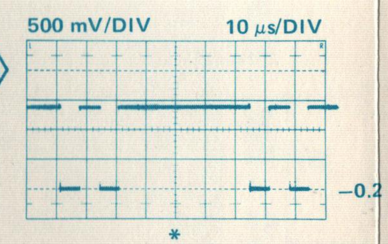
10



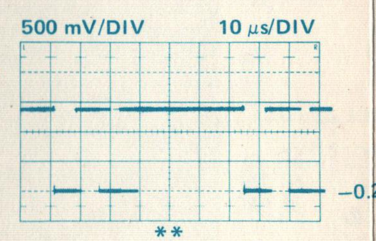
11

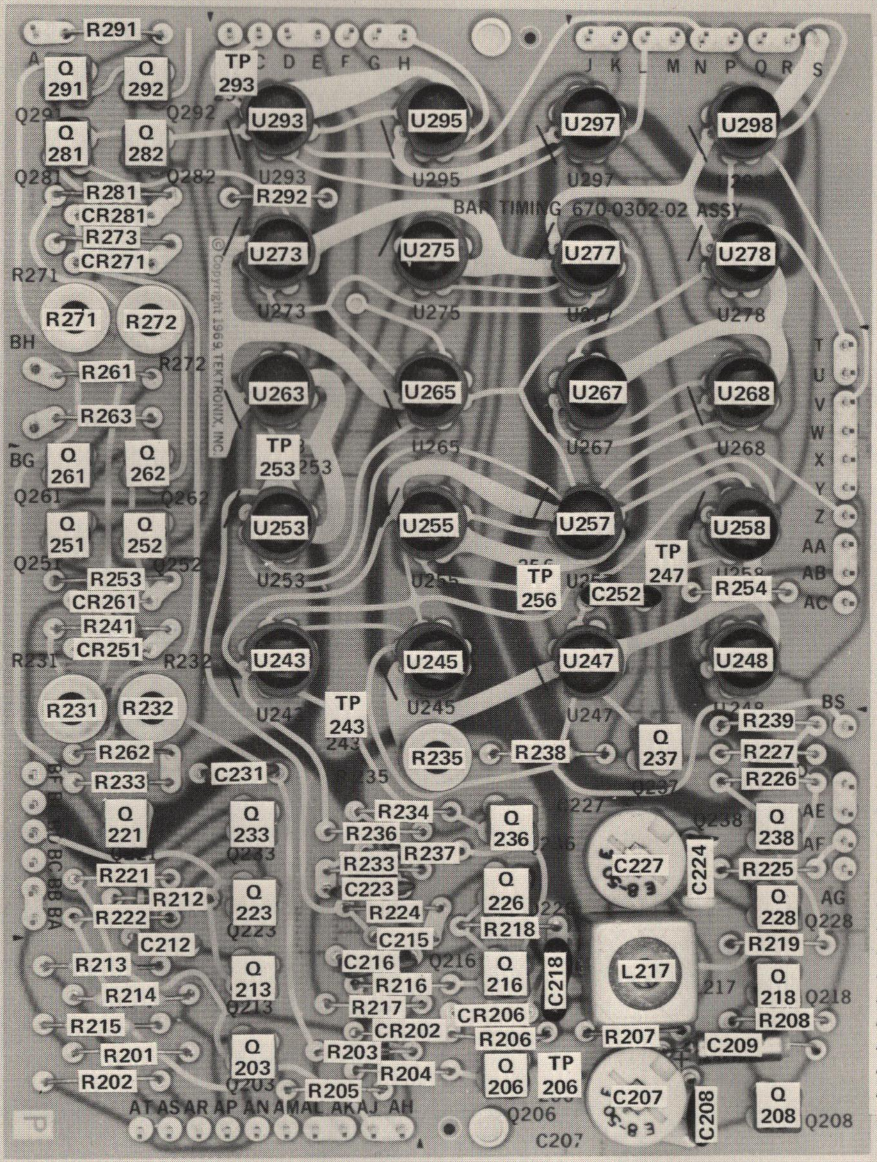


12a



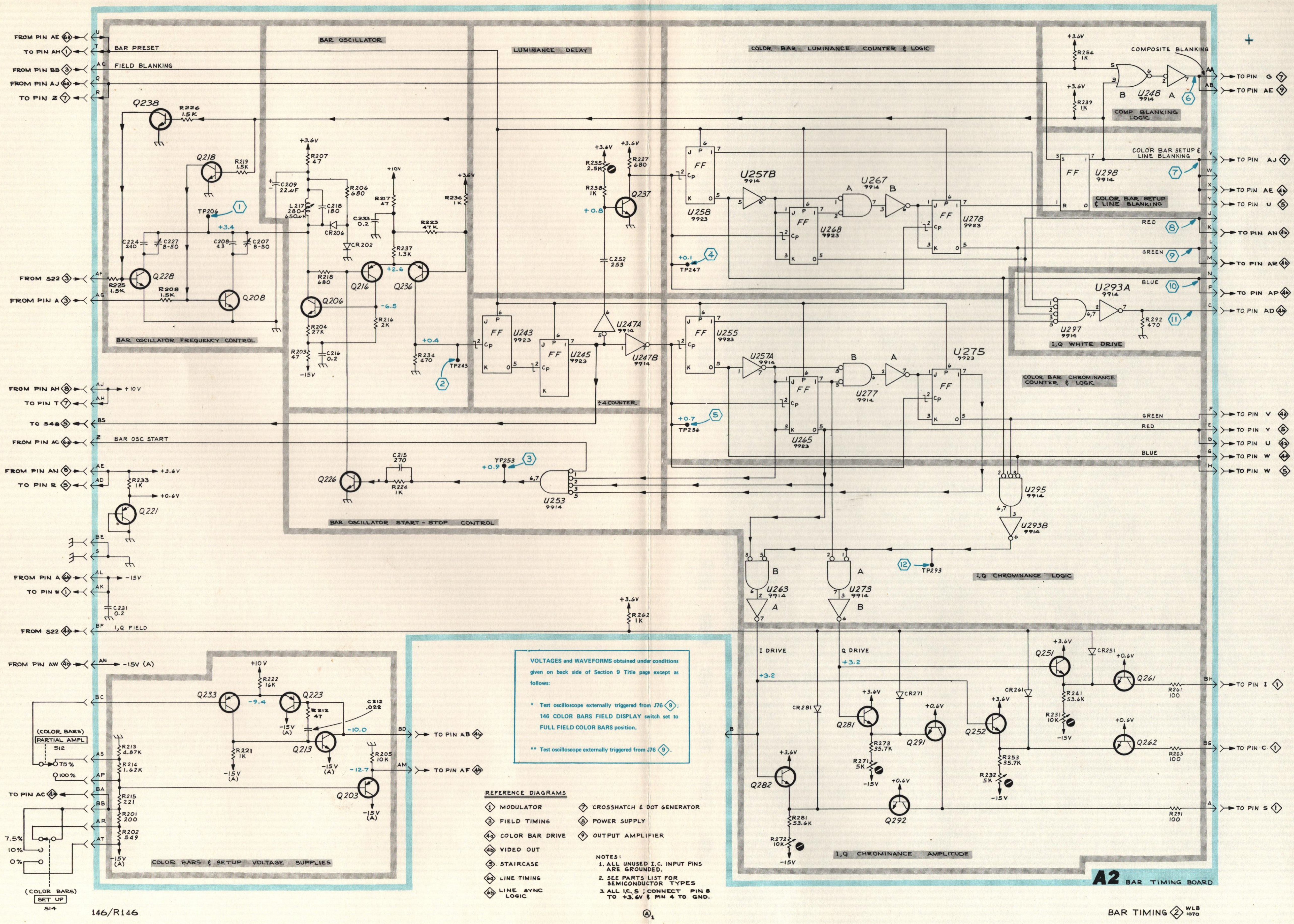
12b





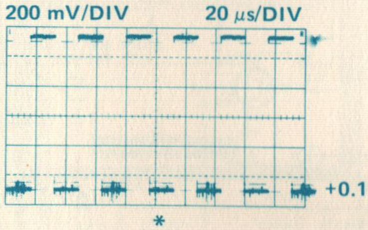
'A' red on wht
'C' blk-red on wht
'D' blk-grn on wht
'E' blk-grn on wht
'F' brn-yel on wht
'G' blk-orn on wht
'H' blk-orn on wht
'K' grn on wht
'M' orn on wht
'P' yel on wht
'Q' gry on wht
'R' gry on wht
'S' blk
'T' brn-red on wht
'U' brn-red on wht
'V' blk-brn on wht
'X' blk-brn on wht
'Y' blk-brn on wht
'Z' blu on wht
'AA' brn-orn on wht
'AB' brn-orn on wht
'AC' brn-gry on wht
'BS' blk on wht
'AD' blk on red
'AE' blk on red
'AF' orn on wht
'AG' brn on wht
'AH' brn on red
'AJ' brn on red
'AK' blk on vio
'AL' blk on vio
'AM' gry on wht
'AN' blk on vio
'AP' blk-orn on wht
'AR' brn-blk on wht
'AS' blk-red on wht
'AT' gry on wht
'BA' blk-orn on wht
'BB' vio on wht
'BC' blu on wht
'BD' blk-yel on wht
'BE' blk
'BF' vio on wht
'BG' blu on wht coax
'BH' yel on wht

Bar Timing A2

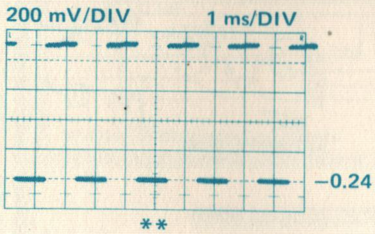


BAR OSCILLATOR
LUMINANCE DELAY
COLOR BAR LUMINANCE COUNTER & LOGIC
COMP BLANKING LOGIC
COLOR BAR SETUP & LINE BLANKING
I,Q WHITE DRIVE
COLOR BAR CHROMINANCE COUNTER & LOGIC
BAR OSCILLATOR FREQUENCY CONTROL
÷4 COUNTER
BAR OSCILLATOR START-STOP CONTROL
I,Q CHROMINANCE LOGIC
I,Q CHROMINANCE AMPLITUDE
COLOR BARS & SETUP VOLTAGE SUPPLIES
VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:
* Test oscilloscope externally triggered from J76 9; 146 COLOR BARS FIELD DISPLAY switch set to FULL FIELD COLOR BARS position.
** Test oscilloscope externally triggered from J76 9.
REFERENCE DIAGRAMS
1 MODULATOR
3 FIELD TIMING
4a COLOR BAR DRIVE
4b VIDEO OUT
5 STAIRCASE
6a LINE TIMING
6b LINE SYNC LOGIC
7 CROSSHATCH & DOT GENERATOR
8 POWER SUPPLY
9 OUTPUT AMPLIFIER
NOTES:
1. ALL UNUSED I.C. INPUT PINS ARE GROUNDED.
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
3. ALL I.C.S ; CONNECT PIN 8 TO +3.6V & PIN 4 TO GND.
A2 BAR TIMING BOARD

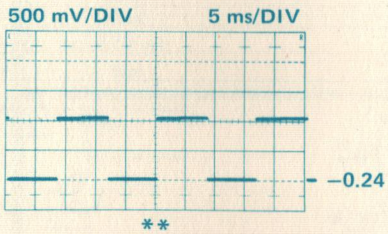
1


200 mV/DIV
20 μs/DIV
+0.1
*

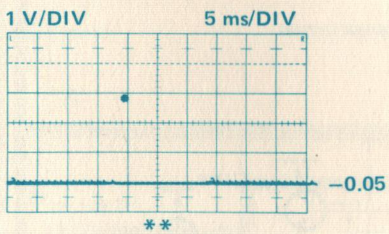
2


200 mV/DIV
1 ms/DIV
−0.24
**

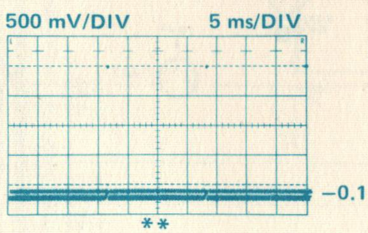
3


500 mV/DIV
5 ms/DIV
−0.24
**

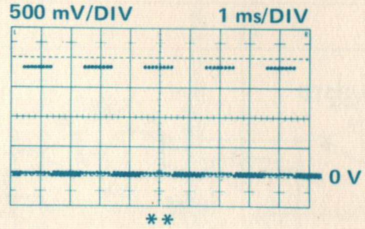
4


1 V/DIV
5 ms/DIV
−0.05
**

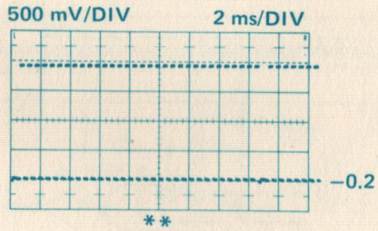
5


500 mV/DIV
5 ms/DIV
−0.1
**

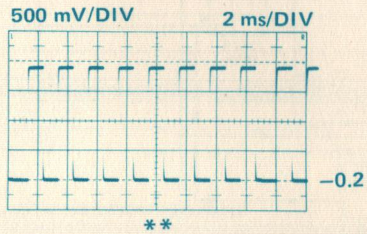
6


500 mV/DIV
1 ms/DIV
0 V
**

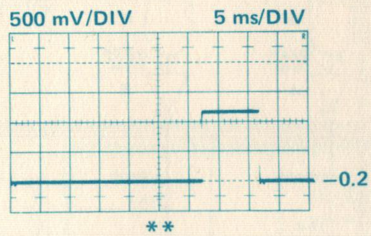
7

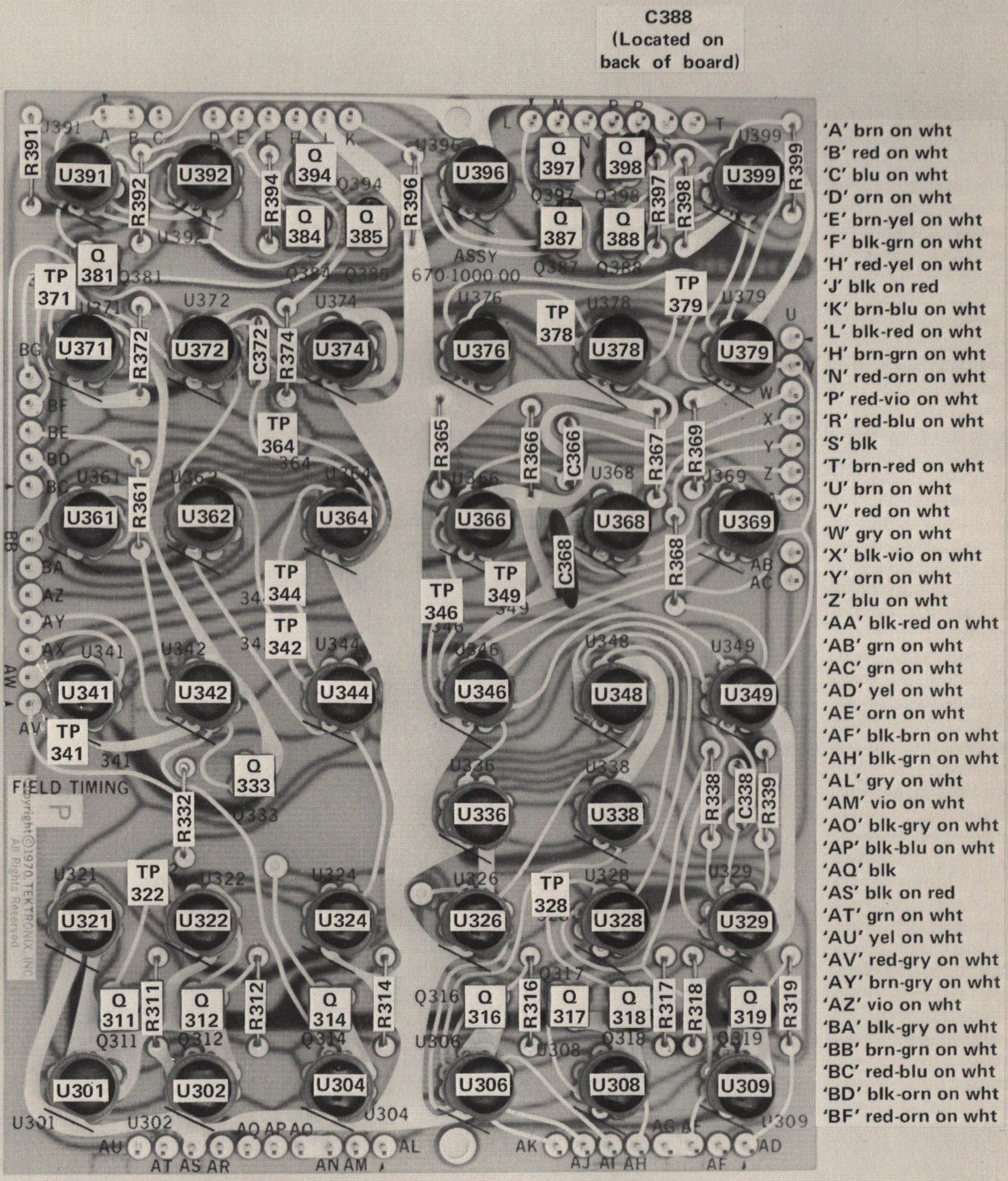

500 mV/DIV
2 ms/DIV
−0.2
**

8

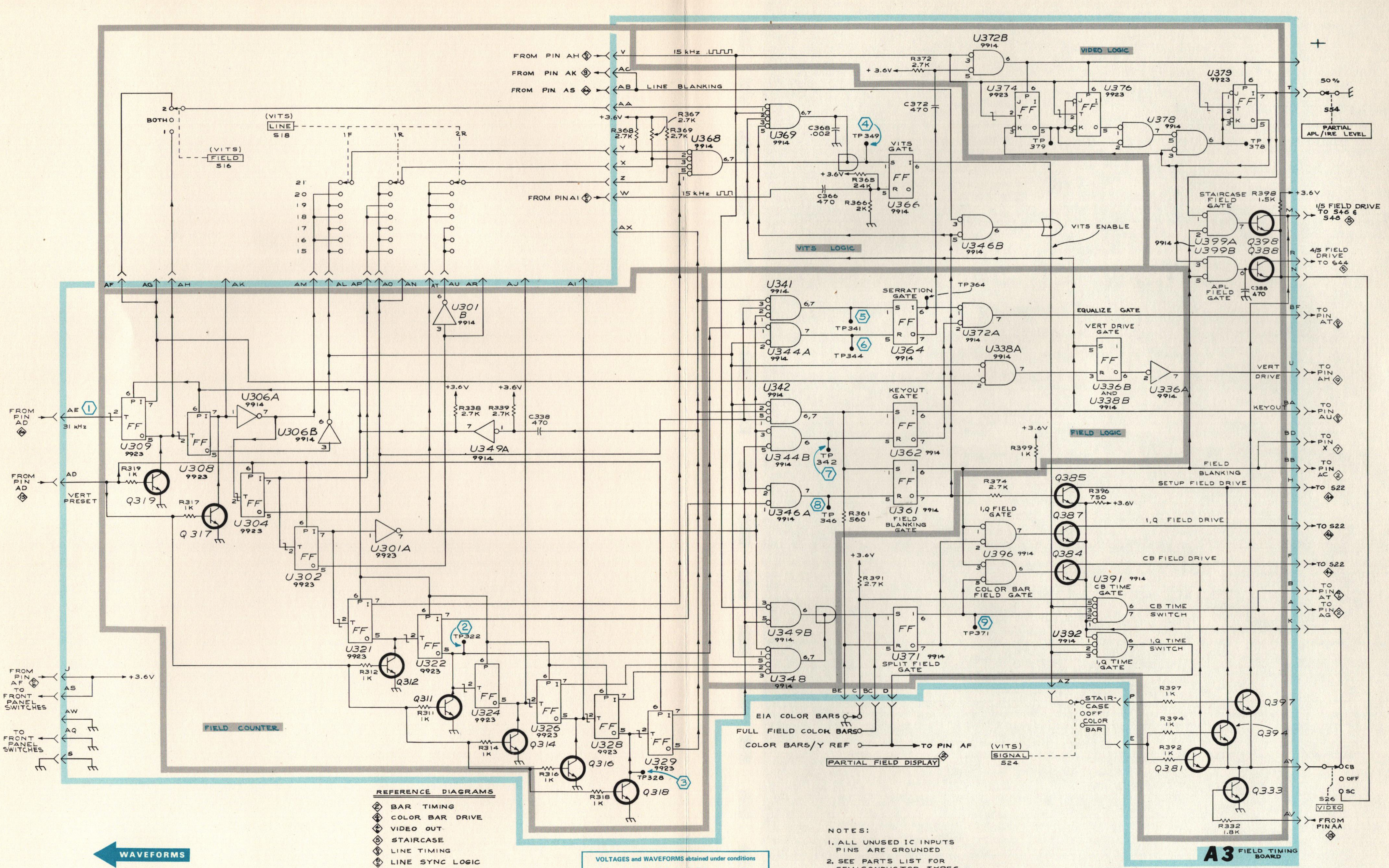

500 mV/DIV
2 ms/DIV
−0.2
**

9


500 mV/DIV
5 ms/DIV
−0.2
**



Field Timing A3



REFERENCE DIAGRAMS

- 2 BAR TIMING
- 4 COLOR BAR DRIVE
- 4 VIDEO OUT
- 5 STAIRCASE
- 5 LINE TIMING
- 6 LINE SYNC LOGIC
- 7 CROSSHATCH & DOT GENERATOR
- 7 OUTPUT AMPLIFIERS
- 10 FIELD SYNC LOGIC

VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:

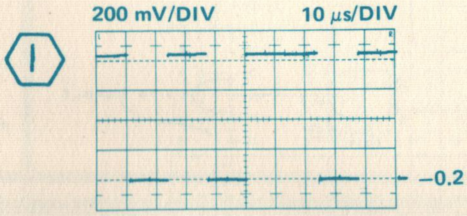
* Test oscilloscope externally triggered from J76 9.

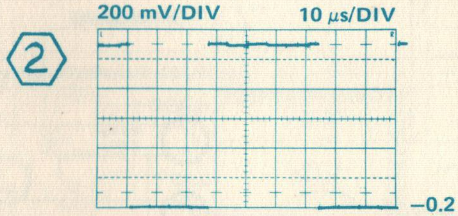
** Test oscilloscope externally triggered from J80 9.

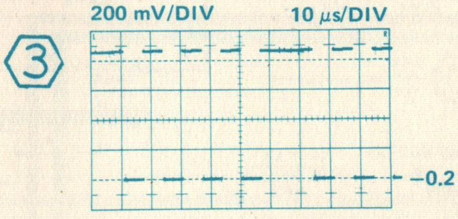
NOTES:

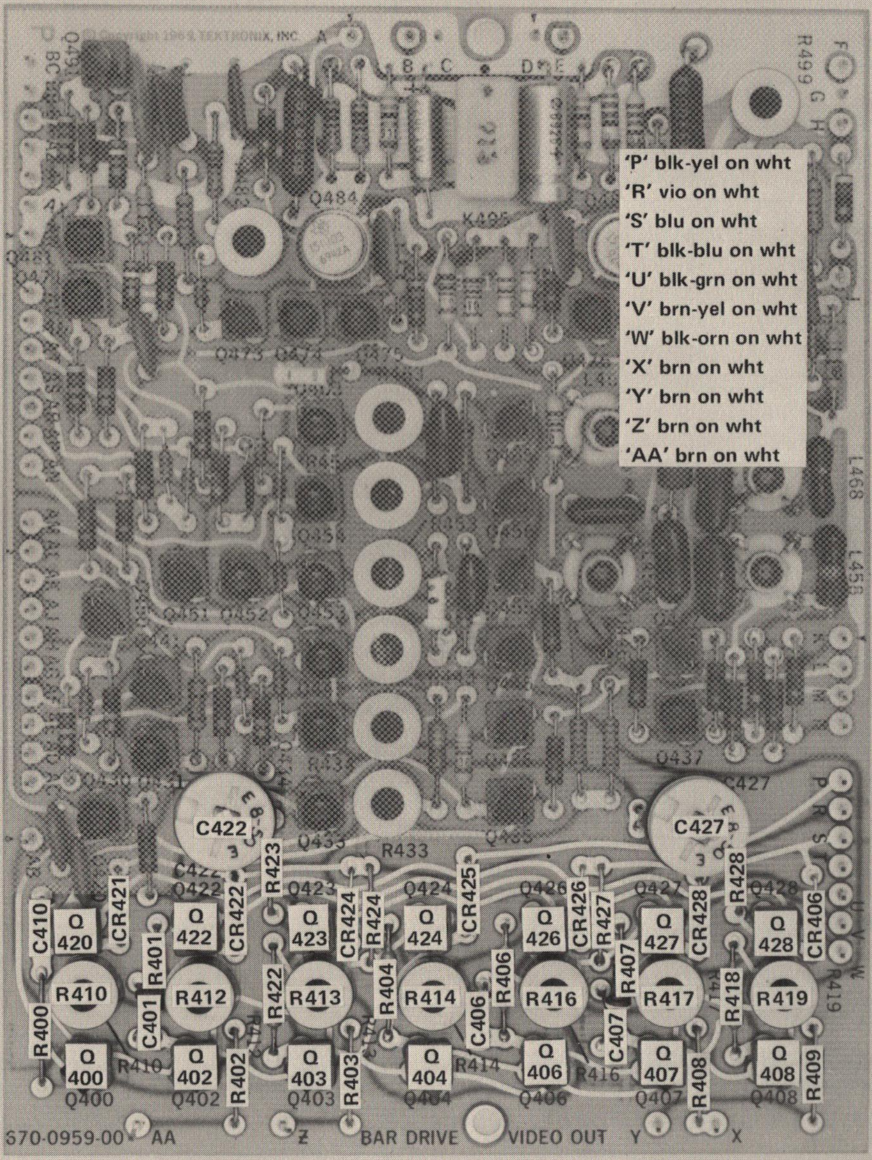
1. ALL UNUSED IC INPUTS PINS ARE GROUNDED
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
3. NO CONNECTION TO PIN 8, U348 & U368.
4. ALL OTHER I.C.'S; CONNECT PIN 8 TO +3.6V.
5. ALL I.C.'S; CONNECT PIN 4 TO GROUND.
6. SWITCHES ARE SHOWN IN STANDARD SIGNAL POSITION

VRS 0271

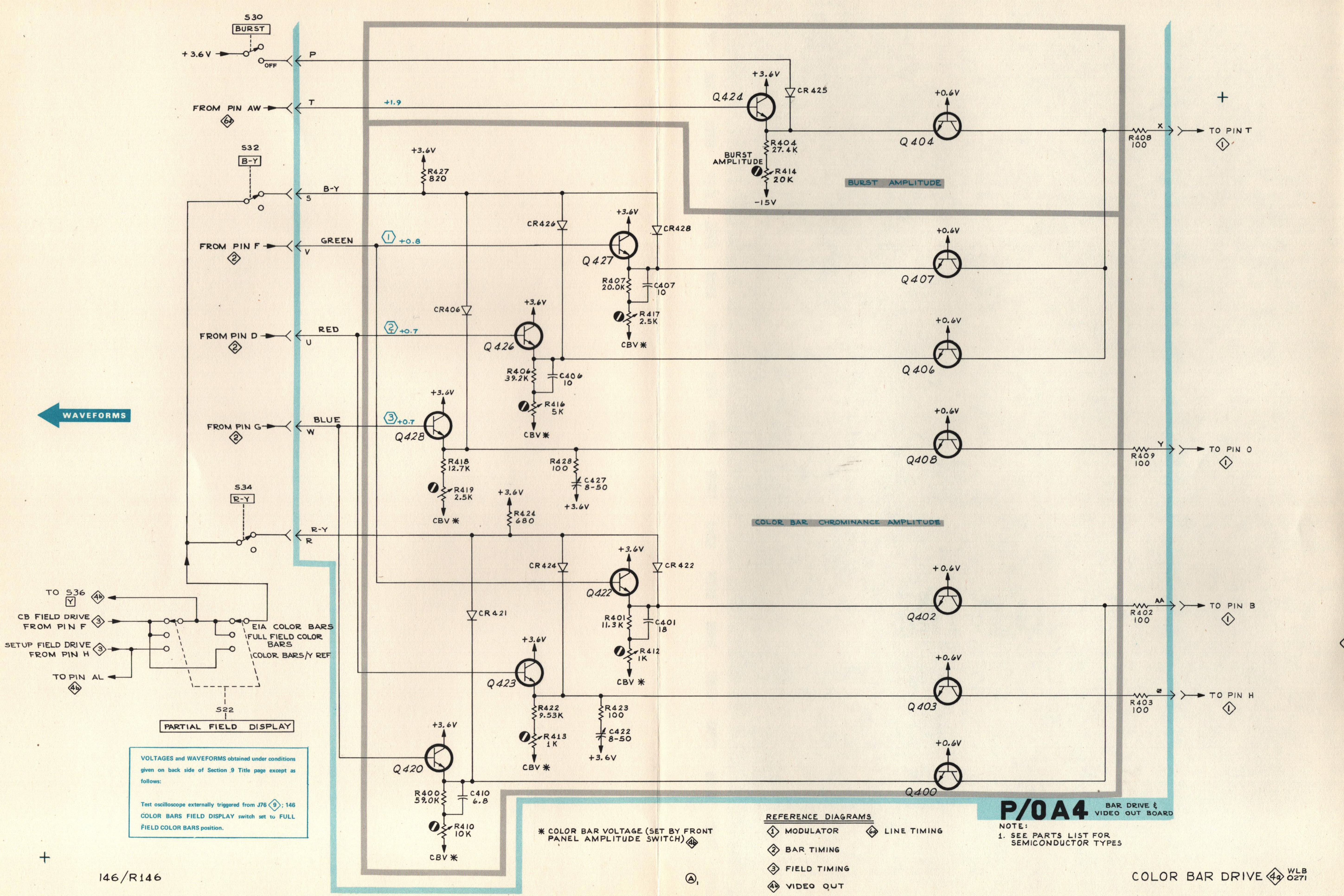

200 mV/DIV
10 μs/DIV
1
−0.2


200 mV/DIV
10 μs/DIV
2
−0.2


200 mV/DIV
10 μs/DIV
3
−0.2



Bar Drive Video Out P/O A4



VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:

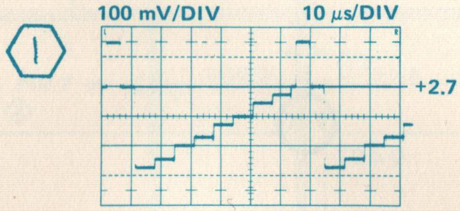
Test oscilloscope externally triggered from J76 ⟨9⟩; 146 COLOR BARS FIELD DISPLAY switch set to FULL FIELD COLOR BARS position.

✱ COLOR BAR VOLTAGE (SET BY FRONT PANEL AMPLITUDE SWITCH) ⟨4a⟩

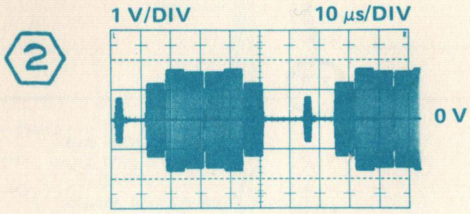
REFERENCE DIAGRAMS
- ⟨1⟩ MODULATOR
- ⟨2⟩ BAR TIMING
- ⟨3⟩ FIELD TIMING
- ⟨4a⟩ VIDEO OUT
- ⟨4b⟩ LINE TIMING

P/0A4 BAR DRIVE & VIDEO OUT BOARD

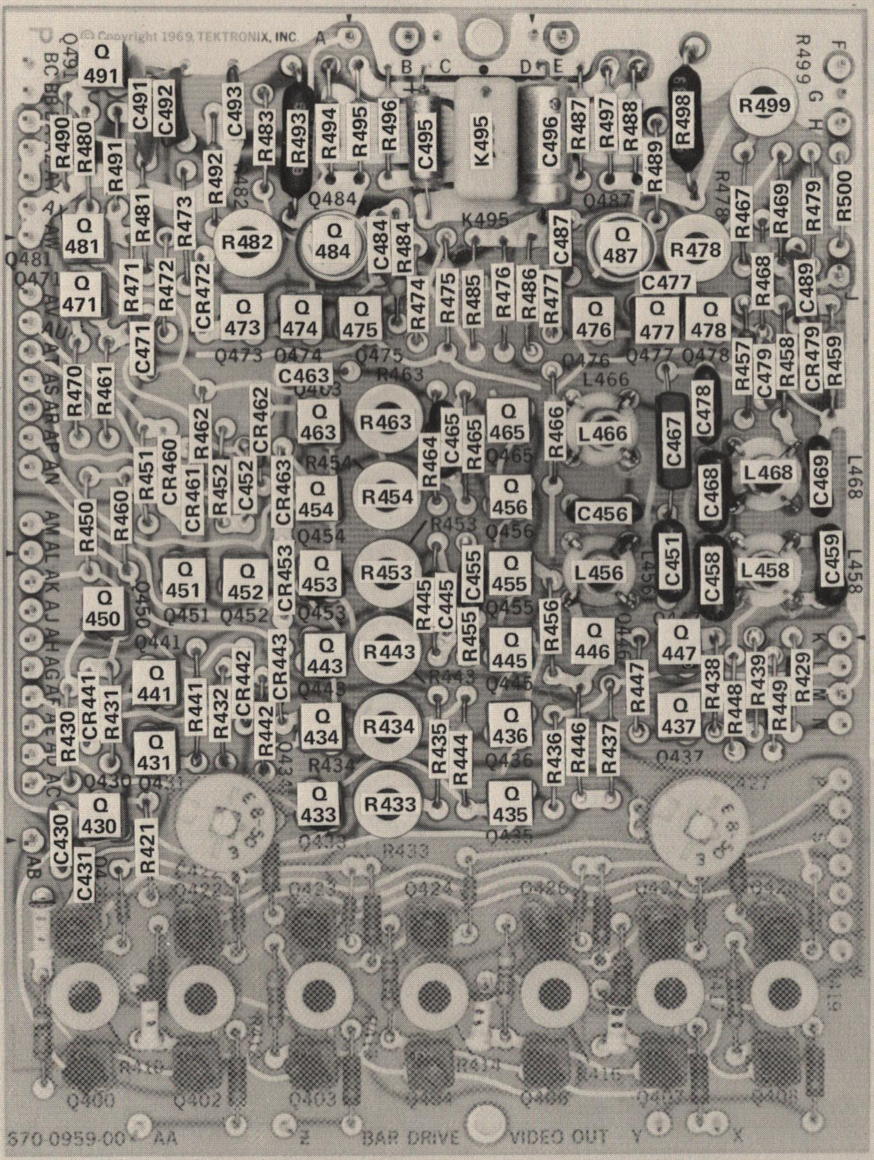
NOTE:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES



1
100 mV/DIV
10 μs/DIV
+2.7

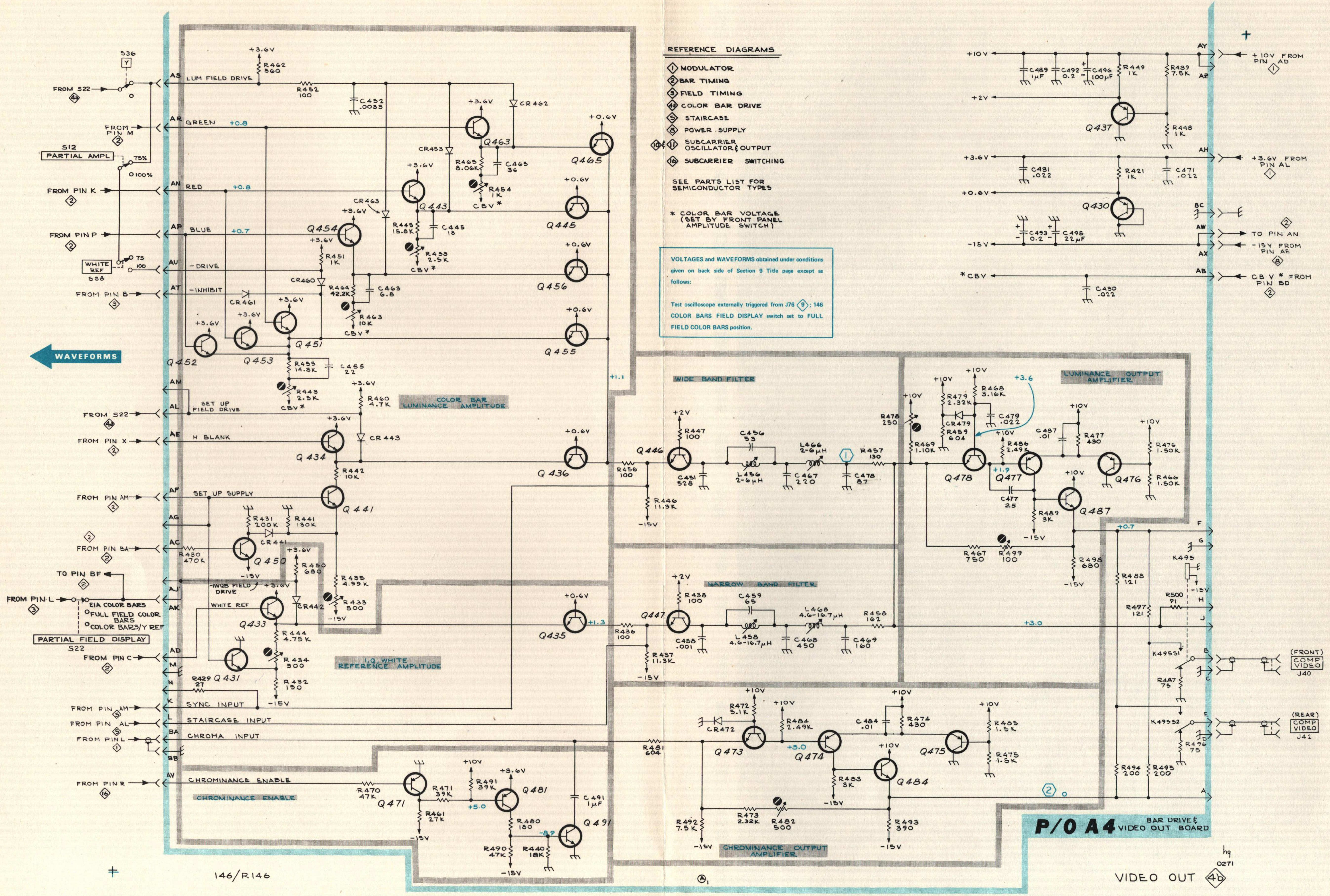


2
1 V/DIV
10 μs/DIV
0 V

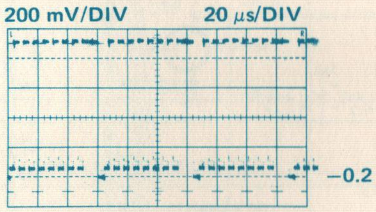


'B' white coax
'C' shield for 'B'
'D' shield for 'E'
'E' orn on wht coax
'K' brn on wht
'L' brn on wht
'AB' blk-yel on wht
'AC' blk-orn on wht
'AD' blk-red on wht
'AE' blk-brn on wht
'AF' gry on wht
'AH' blk on red
'AK' vio on wht
'AM' red-yel on wht
'AN' grn on wht
'AP' yel on wht
'AR' orn on wht
'AS' brn on wht
'AT' red on wht
'AU' blk-orn on wht
'AV' blk-brn on wht
'AW' blk on vio
'AX' blk on vio
'AY' brn on red
'BA' brn on wht coax
'BB' Shield for 'BA'
'BC' blk

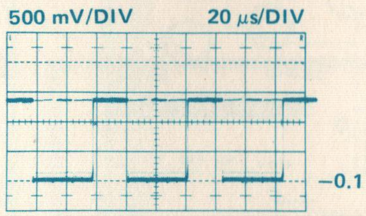
Bar Drive Video Out P/O A4


REFERENCE DIAGRAMS
1 MODULATOR
2 BAR TIMING
3 FIELD TIMING
4 COLOR BAR DRIVE
5 STAIRCASE
6 POWER SUPPLY
10 11 SUBCARRIER OSCILLATOR & OUTPUT
16 SUBCARRIER SWITCHING
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
* COLOR BAR VOLTAGE (SET BY FRONT PANEL AMPLITUDE SWITCH)
VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:
Test oscilloscope externally triggered from J76 9; 146 COLOR BARS FIELD DISPLAY switch set to FULL FIELD COLOR BARS position.
WAVEFORMS
COLOR BAR LUMINANCE AMPLITUDE
I, Q WHITE REFERENCE AMPLITUDE
WIDE BAND FILTER
NARROW BAND FILTER
LUMINANCE OUTPUT AMPLIFIER
CHROMINANCE OUTPUT AMPLIFIER
CHROMINANCE ENABLE
LUM FIELD DRIVE
GREEN
RED
BLUE
-DRIVE
-INHIBIT
SET UP FIELD DRIVE
H BLANK
SET UP SUPPLY
SYNC INPUT
STAIRCASE INPUT
CHROMA INPUT
S12 PARTIAL AMPL
WHITE REF S38
PARTIAL FIELD DISPLAY S22
EIA COLOR BARS
FULL FIELD COLOR BARS
COLOR BARS/Y REF
(FRONT) COMP VIDEO J40
(REAR) COMP VIDEO J42
P/O A4 BAR DRIVE & VIDEO OUT BOARD

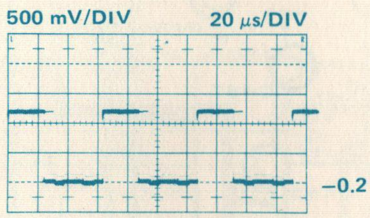
1


200 mV/DIV
20 μs/DIV
−0.2

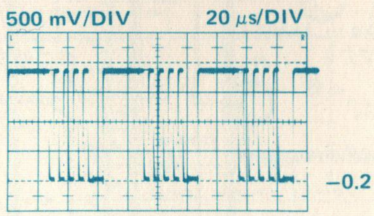
2


500 mV/DIV
20 μs/DIV
−0.1

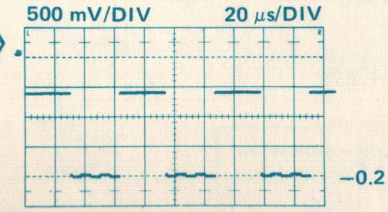
3


500 mV/DIV
20 μs/DIV
−0.2

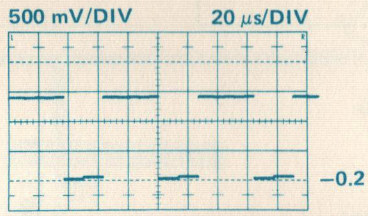
4


500 mV/DIV
20 μs/DIV
−0.2

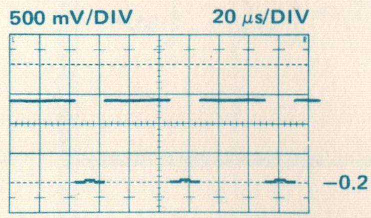
5


500 mV/DIV
20 μs/DIV
−0.2

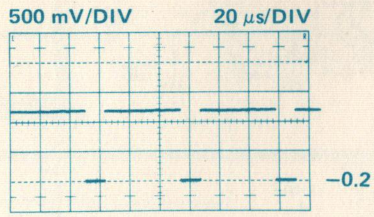
6

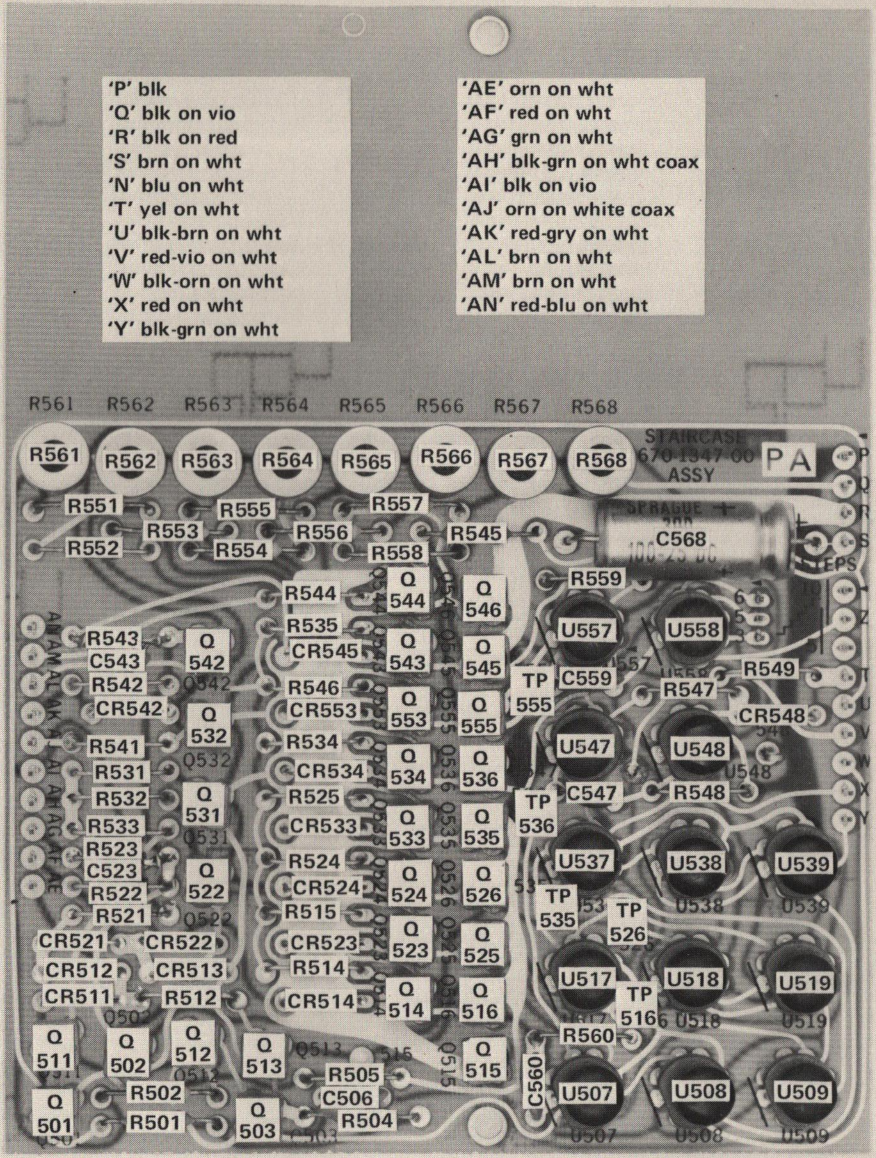

500 mV/DIV
20 μs/DIV
−0.2

7

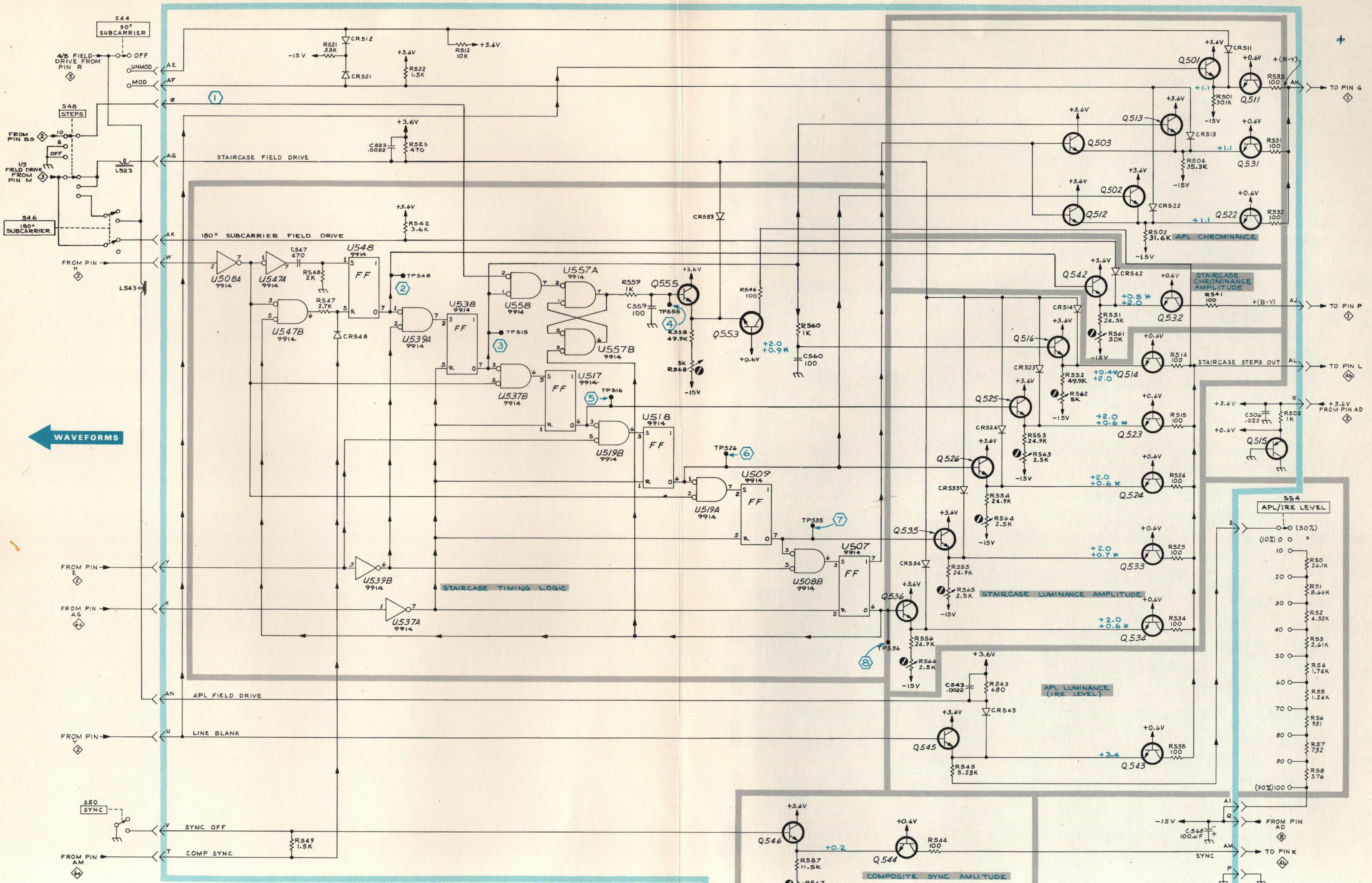

500 mV/DIV
20 μs/DIV
−0.2

8


500 mV/DIV
20 μs/DIV
−0.2



Staircase A5

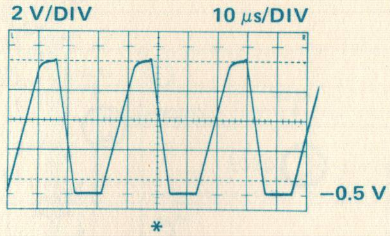


REFERENCE DIAGRAMS

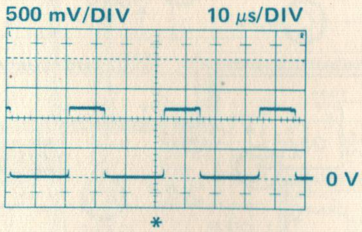
1 MODULATOR
2 BAR TIMING
3 FIELD TIMING
4b VIDEO OUT
4a LINE TIMING
8 POWER SUPPLY

NOTES
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
2. ALL UNUSED I C INPUT PINS ARE GROUNDED.
3. ALL I C; CONNECT PIN 8 TO +3.6V & PIN 4 TO GROUND.

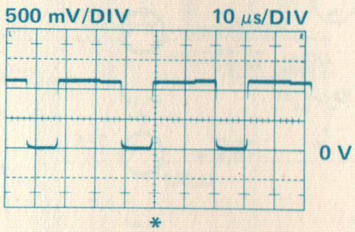
1



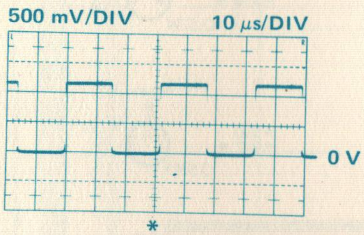
2



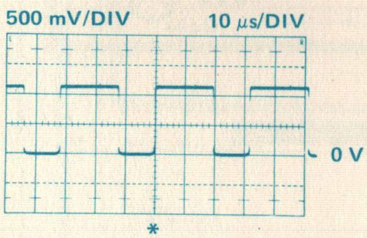
3



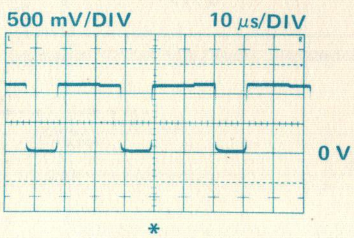
4



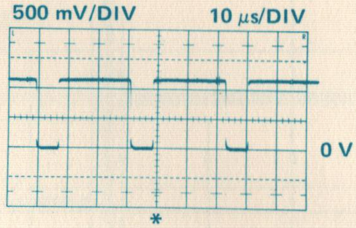
5



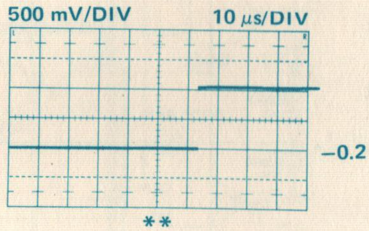
6



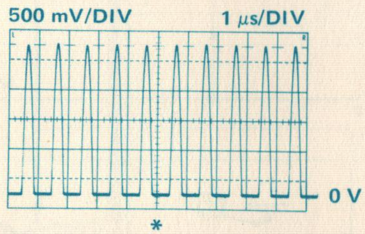
7



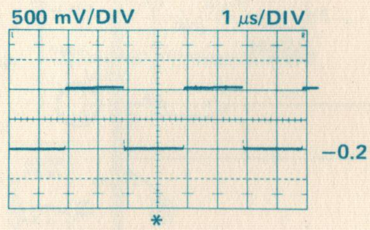
8



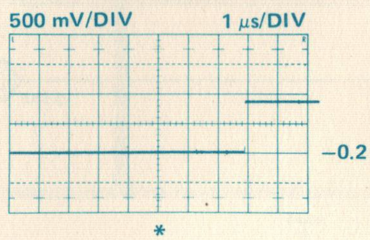
9

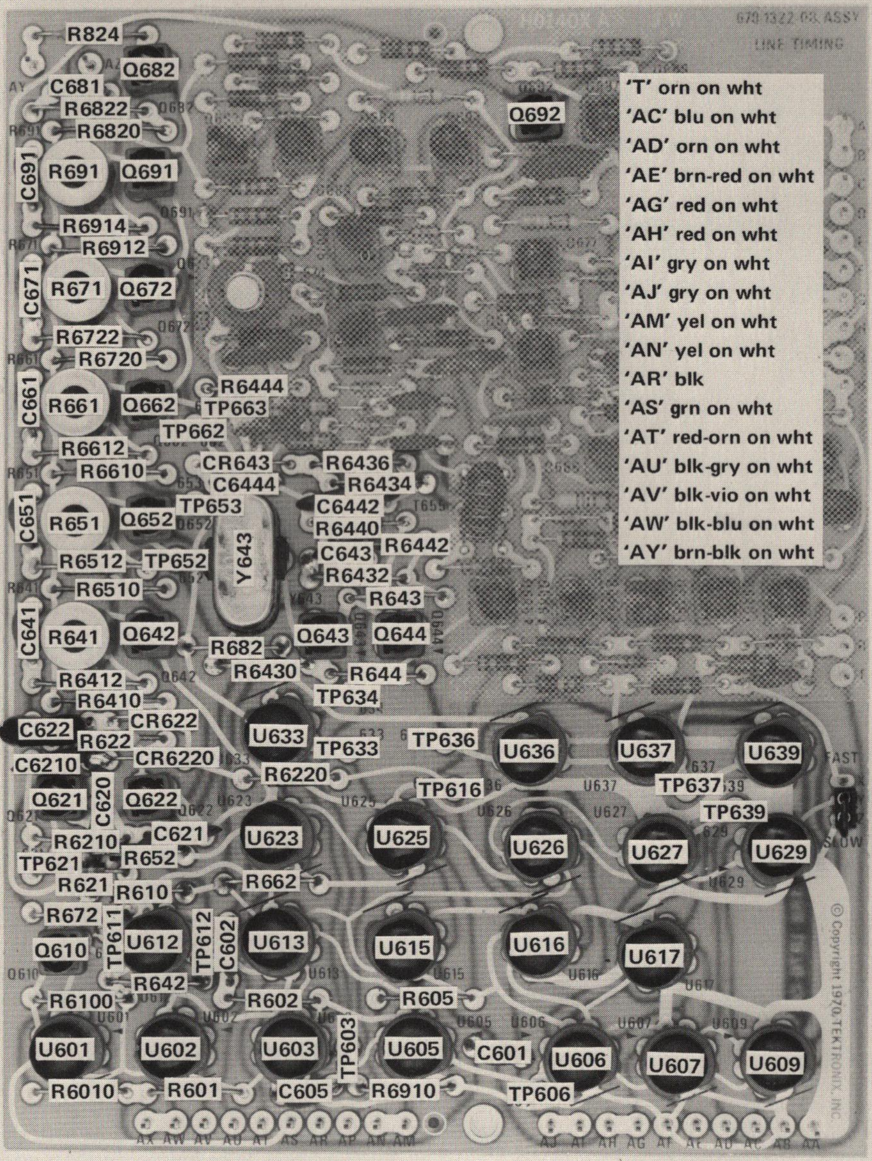


10

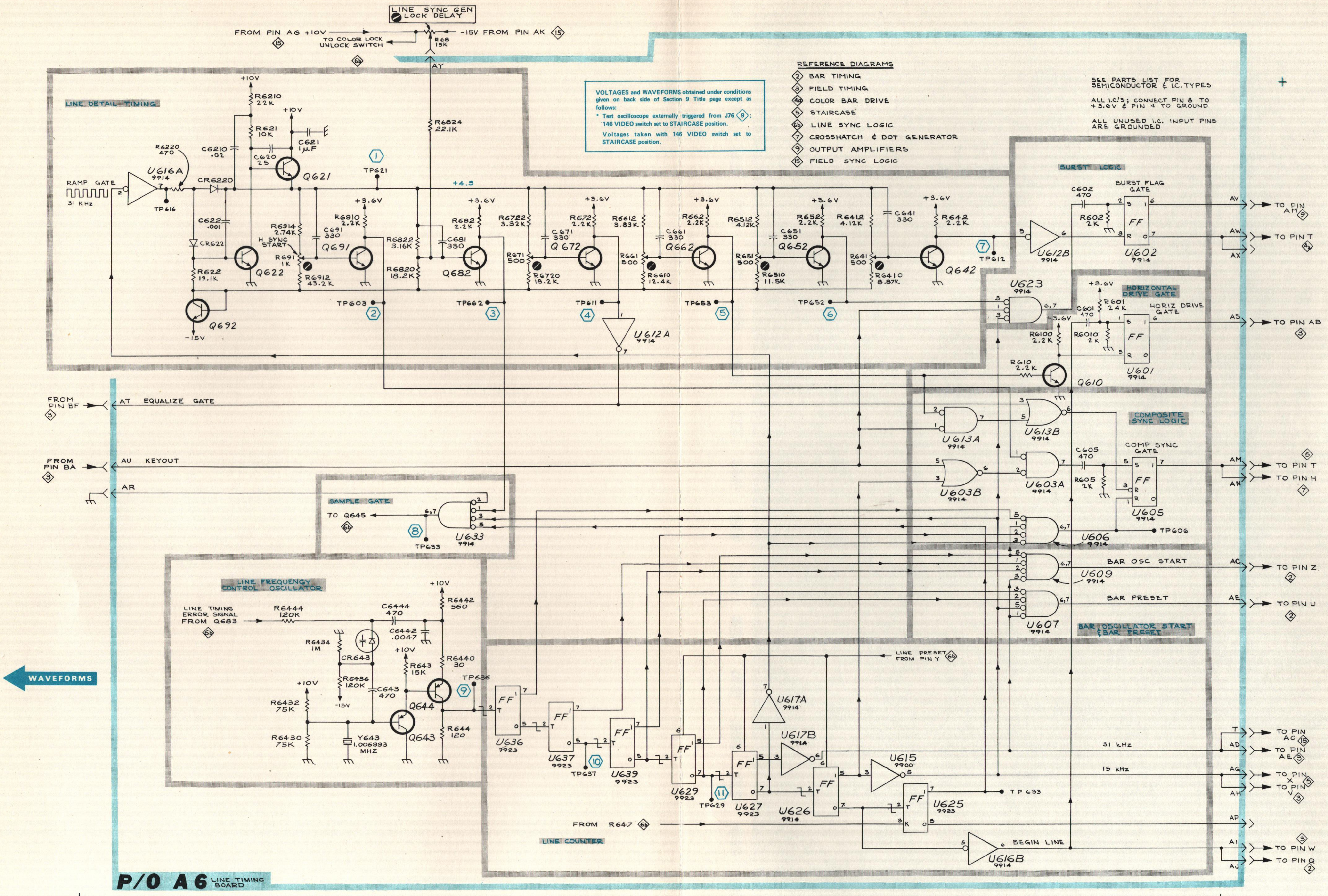


11

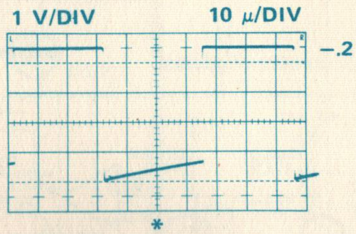




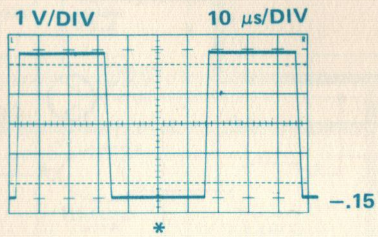
Line Timing P/O A6


LINE SYNC GEN LOCK DELAY
FROM PIN AG +10V
TO COLOR LOCK UNLOCK SWITCH
-15V FROM PIN AK
R68 15K
VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:
* Test oscilloscope externally triggered from J76: 146 VIDEO switch set to STAIRCASE position.
Voltages taken with 146 VIDEO switch set to STAIRCASE position.
REFERENCE DIAGRAMS
2 BAR TIMING
3 FIELD TIMING
4a COLOR BAR DRIVE
5 STAIRCASE
6b LINE SYNC LOGIC
7 CROSSHATCH & DOT GENERATOR
9 OUTPUT AMPLIFIERS
15 FIELD SYNC LOGIC
SEE PARTS LIST FOR SEMICONDUCTOR & I.C. TYPES
ALL I.C.'S; CONNECT PIN 8 TO +3.6V & PIN 4 TO GROUND
ALL UNUSED I.C. INPUT PINS ARE GROUNDED
LINE DETAIL TIMING
RAMP GATE
31 KHz
U616A 9914
BURST LOGIC
BURST FLAG GATE
U602 9914
U612B 9914
HORIZONTAL DRIVE GATE
HORIZ DRIVE GATE
U601 9914
U623 9914
Q610
COMPOSITE SYNC LOGIC
COMP SYNC GATE
U613A 9914
U613B 9914
U603A 9914
U603B 9914
U605 9914
U606 9914
U609 9914
U607 9914
BAR OSC START
BAR PRESET
BAR OSCILLATOR START & BAR PRESET
FROM PIN BF
AT EQUALIZE GATE
FROM PIN BA
AU KEYOUT
AR
SAMPLE GATE
TO Q645
U633 9914
LINE FREQUENCY CONTROL OSCILLATOR
LINE TIMING ERROR SIGNAL FROM Q683
Y643 1.006993 MHZ
WAVEFORMS
LINE PRESET FROM PIN Y
U617A 9914
U617B 9914
U615 9900
U636 9923
U637 9923
U639 9923
U629 9923
U627 9923
U626 9914
U625 9923
U616B 9914
31 kHz
15 kHz
FROM R647
BEGIN LINE
LINE COUNTER
TO PIN AM
TO PIN T
TO PIN AB
TO PIN H
TO PIN Z
TO PIN U
TO PIN AC
TO PIN AE
TO PIN X
TO PIN V
TO PIN W
TO PIN Q
P/O A6 LINE TIMING BOARD

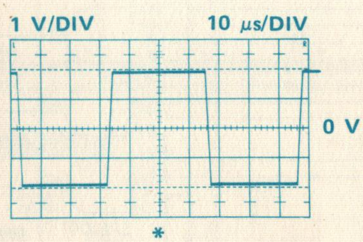
1


1 V/DIV
10 μ/DIV
−.2
*

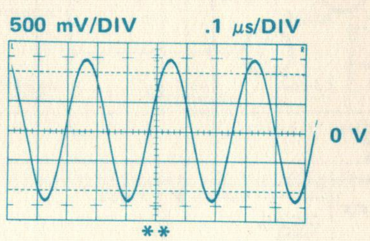
2

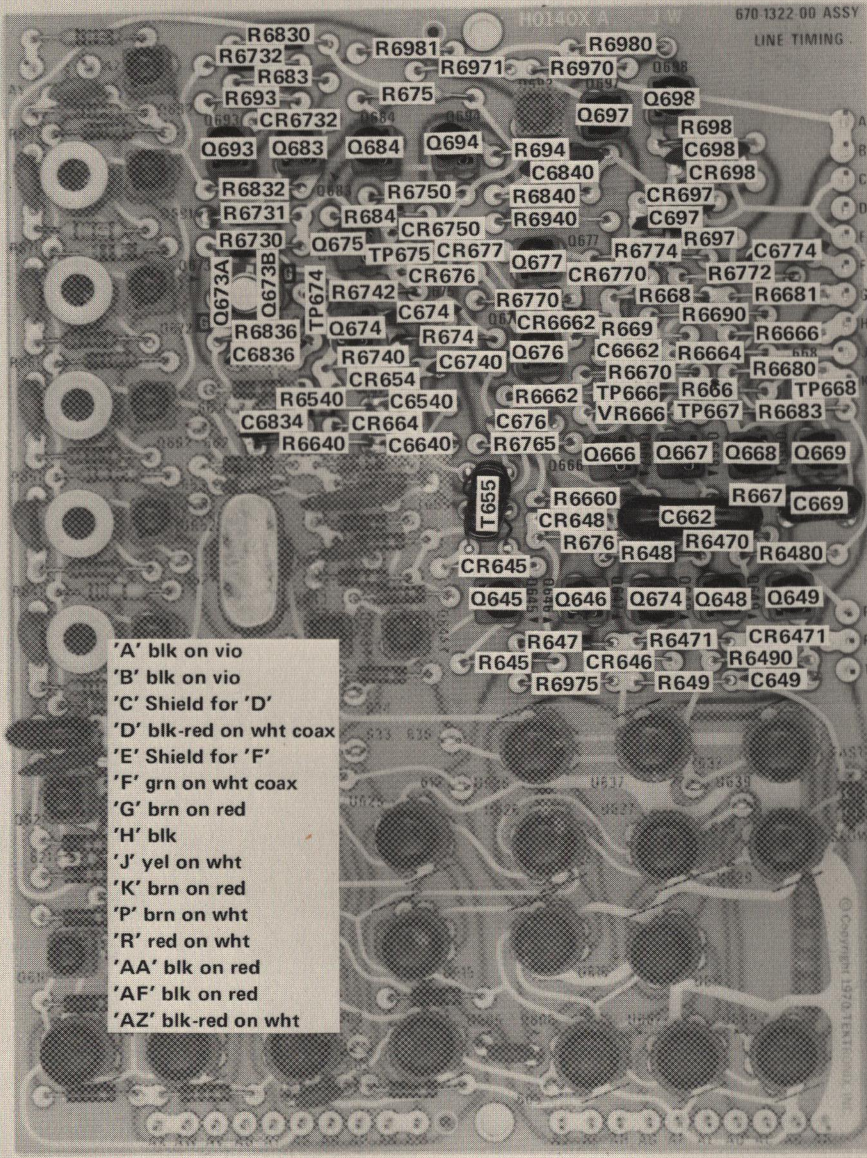

1 V/DIV
10 μs/DIV
−.15
*

3a

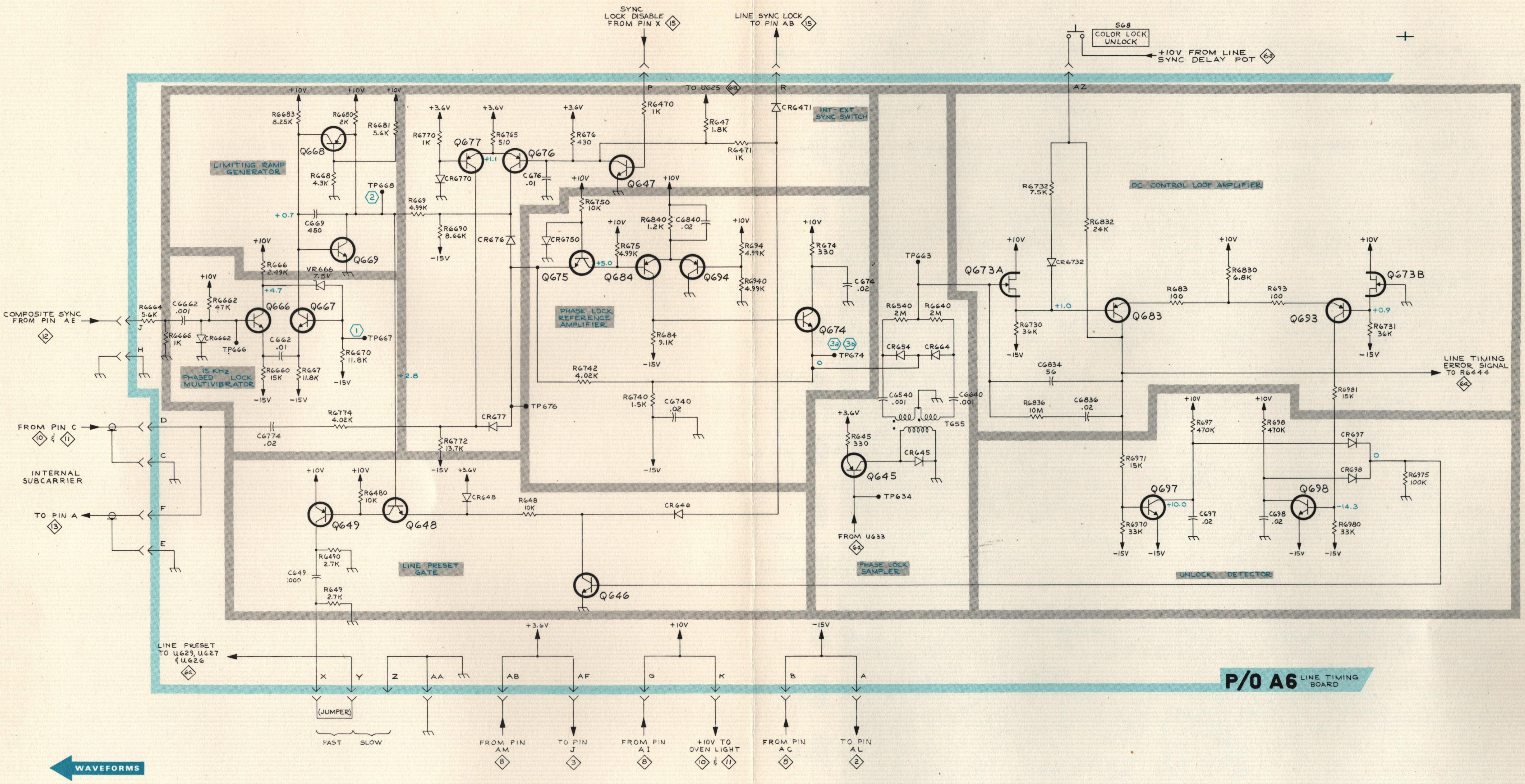

1 V/DIV
10 μs/DIV
0 V
*

3b


500 mV/DIV
.1 μs/DIV
0 V
**



Line Timing P/O A6



REFERENCE DIAGRAMS

- 2 BAR TIMING
- 3 FIELD TIMING
- 6a LINE TIMING
- 8 POWER SUPPLY
- 10 & 11 SUBCARRIER OSCILLATOR & OUTPUT
- 12 SYNC STRIP & CHROMA AGC AMP
- 13 QUAD DEMODULATORS
- 15 FIELD SYNC LOGIC

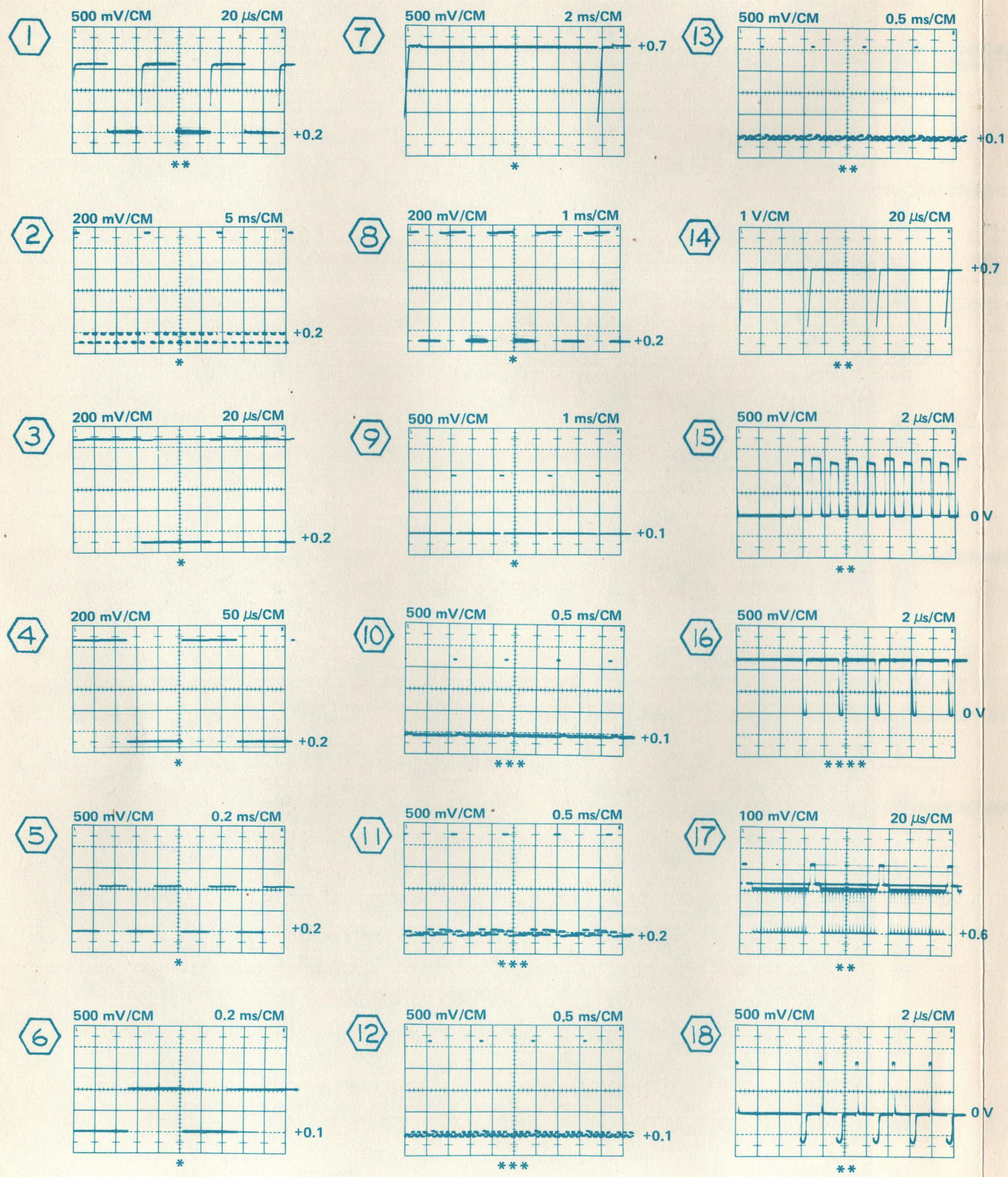
NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:

Test oscilloscope externally triggered from J76 9: 146 SYNCHRONIZATION REF switch set to COLOR GEN LOCK position; 1 V P-P external composite video applied to 146 GEN LOCK Input J60 12

** Test oscilloscope internally triggered.

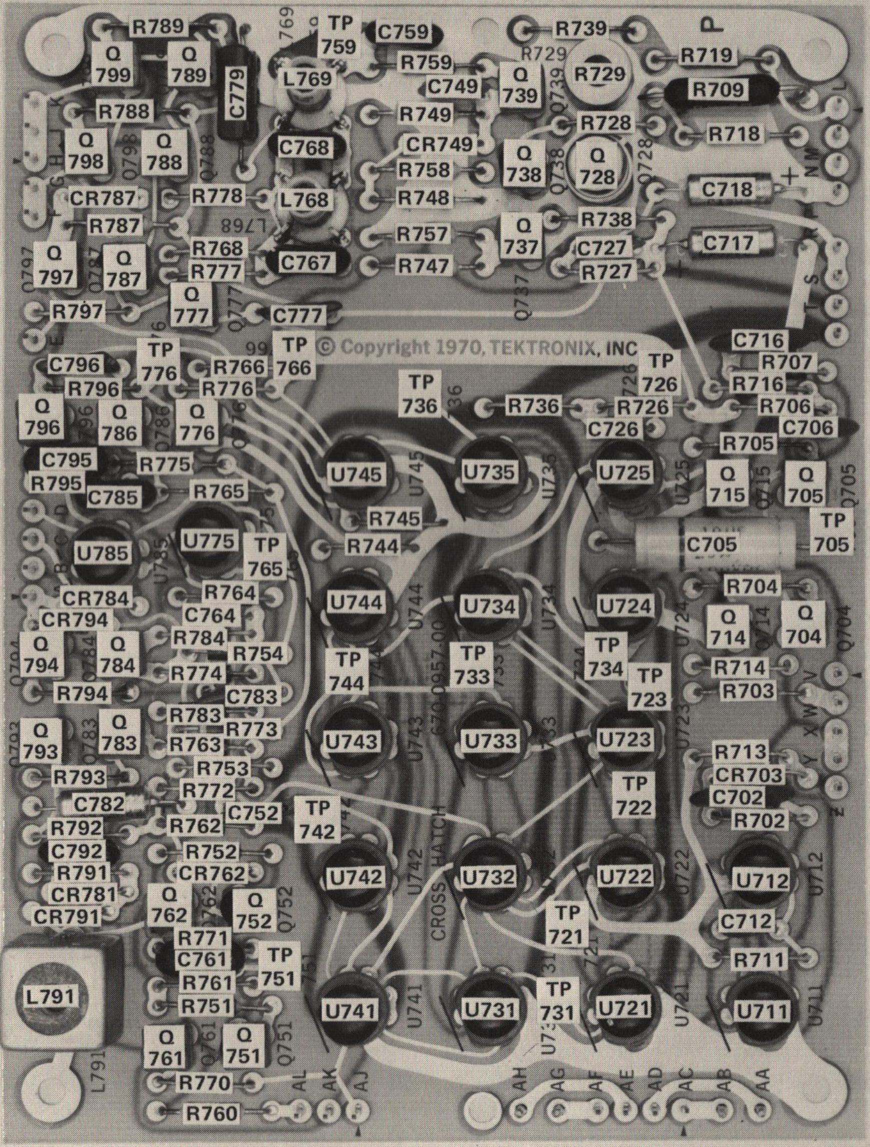
LINE SYNC LOGIC 6b


1
500 mV/CM
20 µs/CM
+0.2
**
2
200 mV/CM
5 ms/CM
+0.2
*
3
200 mV/CM
20 µs/CM
+0.2
*
4
200 mV/CM
50 µs/CM
+0.2
*
5
500 mV/CM
0.2 ms/CM
+0.2
*
6
500 mV/CM
0.2 ms/CM
+0.1
*
7
500 mV/CM
2 ms/CM
+0.7
*
8
200 mV/CM
1 ms/CM
+0.2
*
9
500 mV/CM
1 ms/CM
+0.1
*
10
500 mV/CM
0.5 ms/CM
+0.1
***
11
500 mV/CM
0.5 ms/CM
+0.2
***
12
500 mV/CM
0.5 ms/CM
+0.1
***
13
500 mV/CM
0.5 ms/CM
+0.1
**
14
1 V/CM
20 µs/CM
+0.7
**
15
500 mV/CM
2 µs/CM
0 V
**
16
500 mV/CM
2 µs/CM
0 V
****
17
100 mV/CM
20 µs/CM
+0.6
**
18
500 mV/CM
2 µs/CM
0 V
**

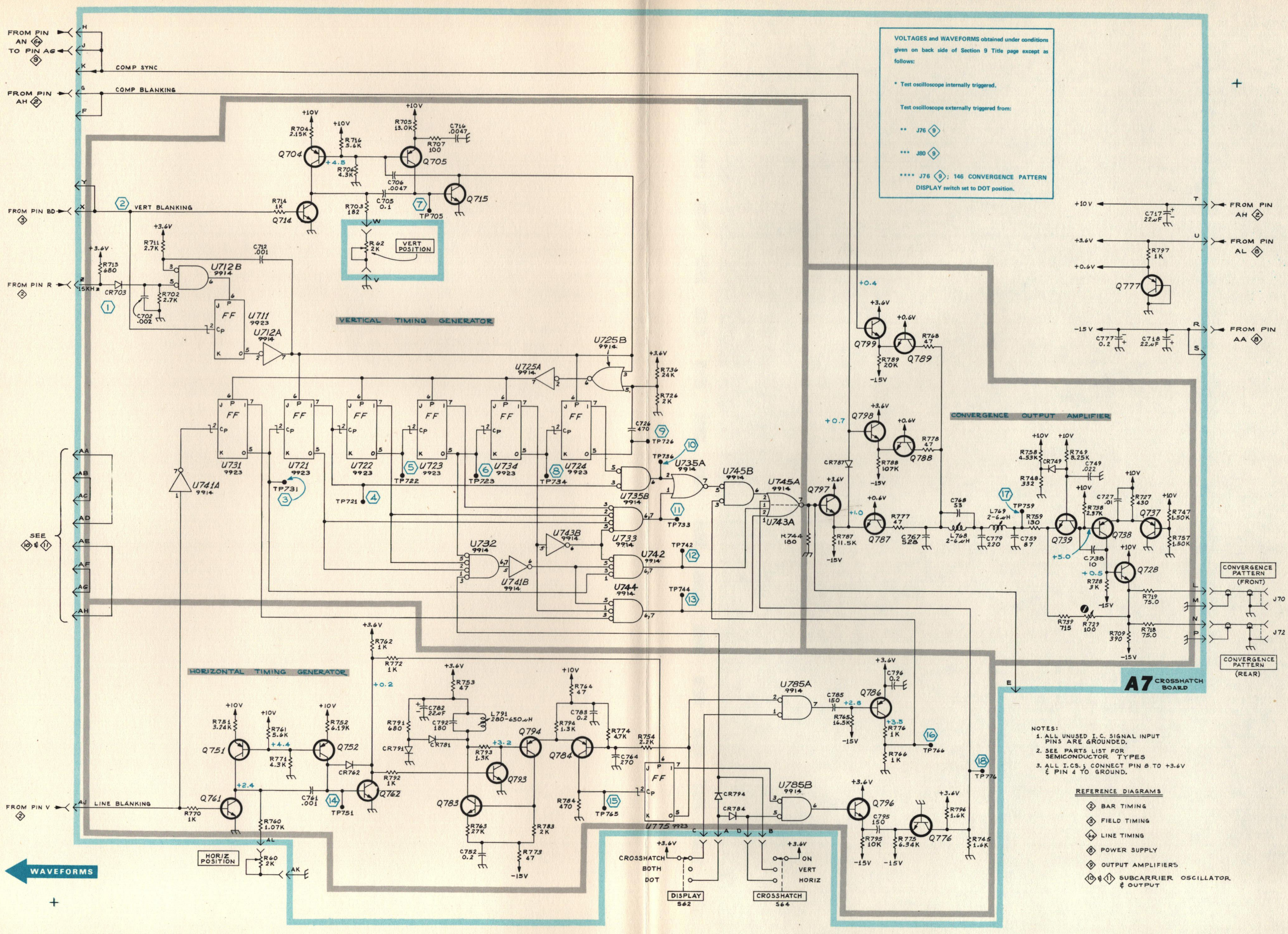
'A' red-gry on wht
'B' orn on wht
'C' red on wht
'D' brn on wht
'G' brn-orn on wht
'H' yel on wht
'J' yel on wht
'L' blk-vio on wht coax
'M' Shield for 'L'
'N' brn on wht coax

'P' Shield for 'N'
'R' blk on vio
'T' brn on red
'U' blk on red
'V' blk
'W' red-blu on wht
'Y' blk-orn on wht
'Z' gry on wht
'AA' Shield for 'AB'
'AB' red-red on gry coax

'AC' red on wht coax
'AD' Shield for 'AC'
'AE' Shield for 'AF'
'AF' wht coax
'AG' gry coax
'AH' Shield for 'AG'
'AJ' blk-brn on wht
'AK' blk
'AL' red-vio on wht



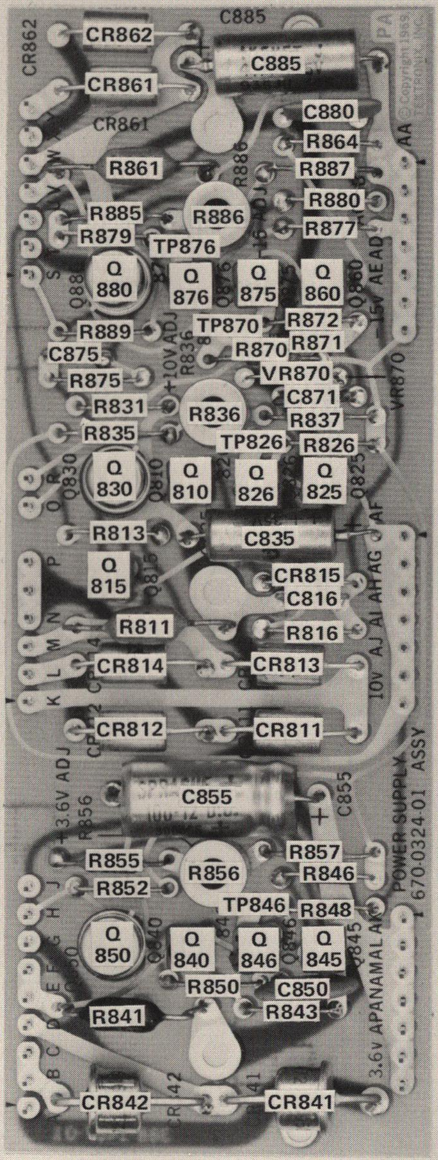
Cross Hatch A7



146/R146

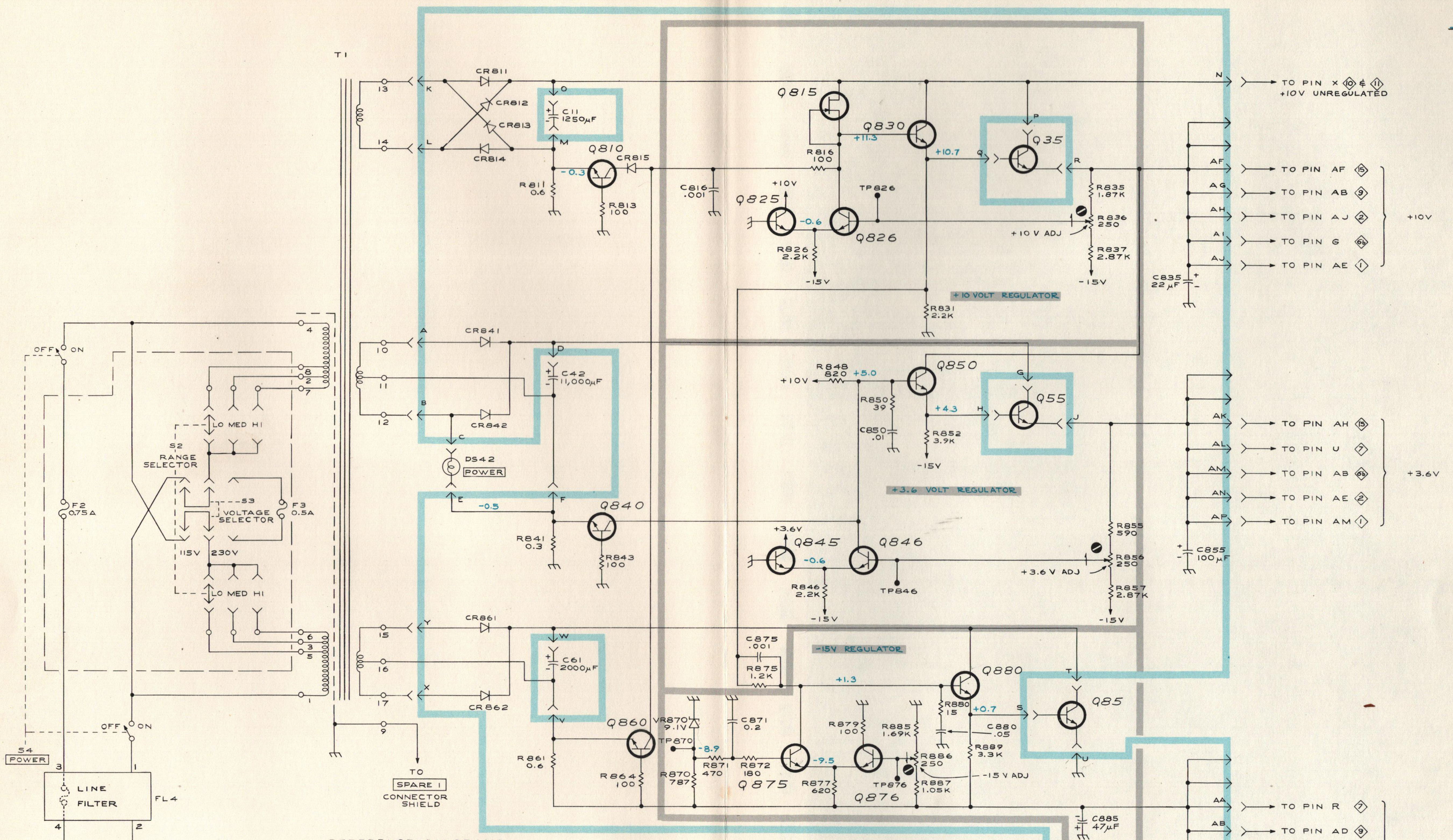
CROSSHATCH & DOT GENERATOR 7 WLB 0271

CROSSHATCH & DOT GENERATOR



'A' orn on gry
'B' yel on gry
'C' yel on gry
'D' blk-wht on red
'E' vio on gry
'F' vio on gry
'G' blk-wht on red
'H' yel on wht
'J' blk on red
'K' brn on gry
'L' red on gry
'M' orn on wht
'N' blk on wht
'O' brn-wht on red
'P' brn-wht on red
'Q' vio on wht
'R' brn on red
'S' blu on wht
'T' blk-wht on vio
'U' blk
'V' blk on vio
'W' vlk-wht on vio
'X' grn on gry
'Y' blu on gry
'AA' blk on vio
'AB' blk on vio
'AC' blk on vio
'AD' blk on vio
'AE' blk on vio
'AF' brn on red
'AG' brn on red
'AH' brn on red
'AI' brn on red
'AH' brn on red
'AK' blk on red
'AL' blk on red
'AM' blk on red
'AN' blk on red
'AP' blk on red

Power Supply A8



REFERENCE DIAGRAMS

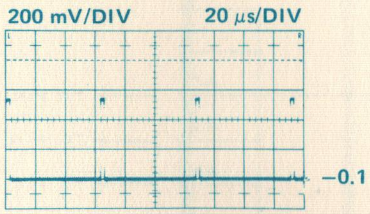
1. MODULATOR
2. BAR TIMING
4b. VIDEO OUT
5. STAIRCASE
6b. LINE SYNC LOGIC
7. CROSSHATCH & DOT GENERATOR
9. OUTPUT AMPLIFIERS
10. & 11. SUBCARRIER OSCILLATOR & OUTPUT
15. FIELD SYNC LOGIC

NOTES

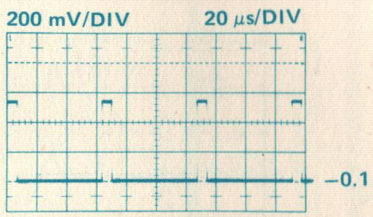
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES obtained under conditions given on back side of Section 9 Title page.

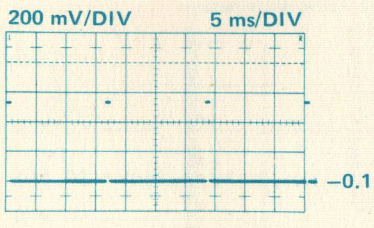
1


200 mV/DIV
20 μs/DIV
−0.1

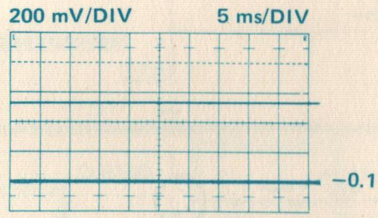
2


200 mV/DIV
20 μs/DIV
−0.1

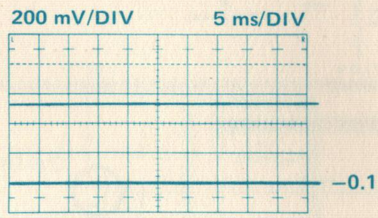
3


200 mV/DIV
5 ms/DIV
−0.1

4


200 mV/DIV
5 ms/DIV
−0.1

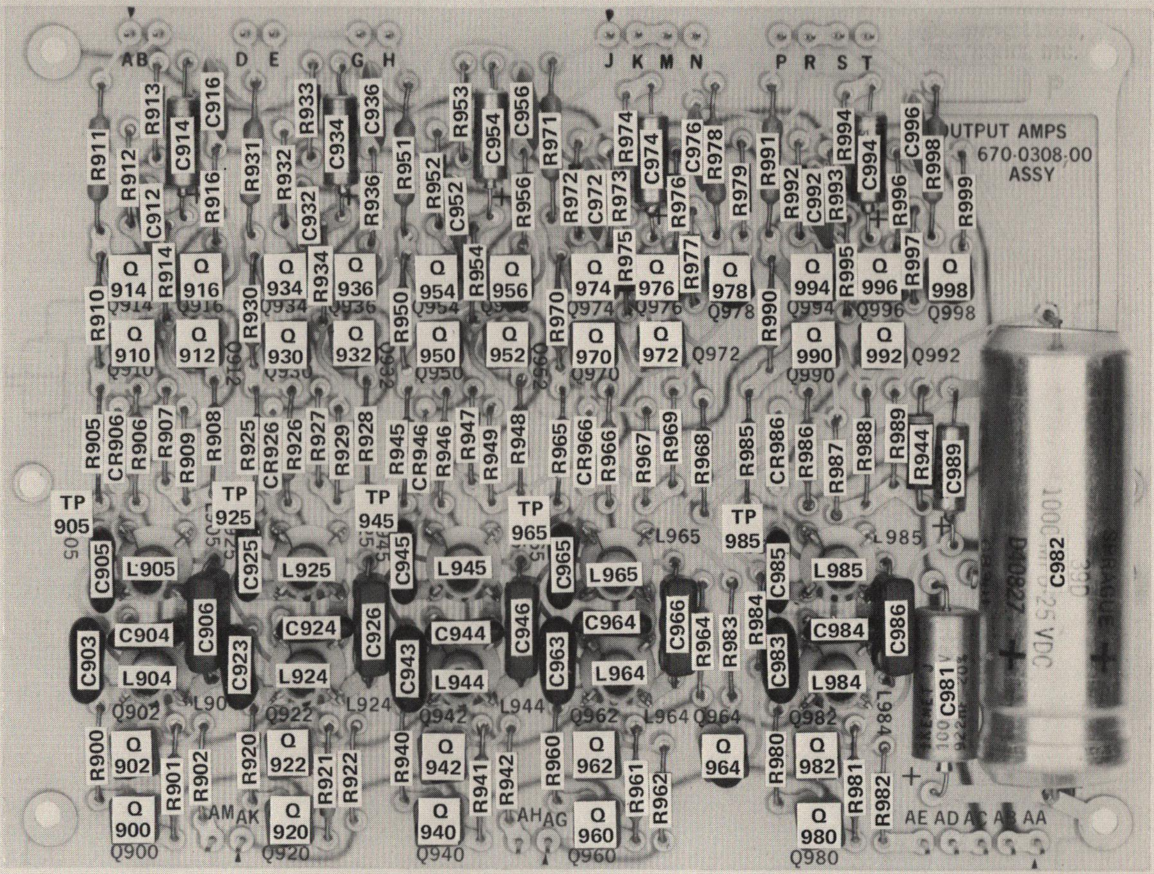
5


200 mV/DIV
5 ms/DIV
−0.1

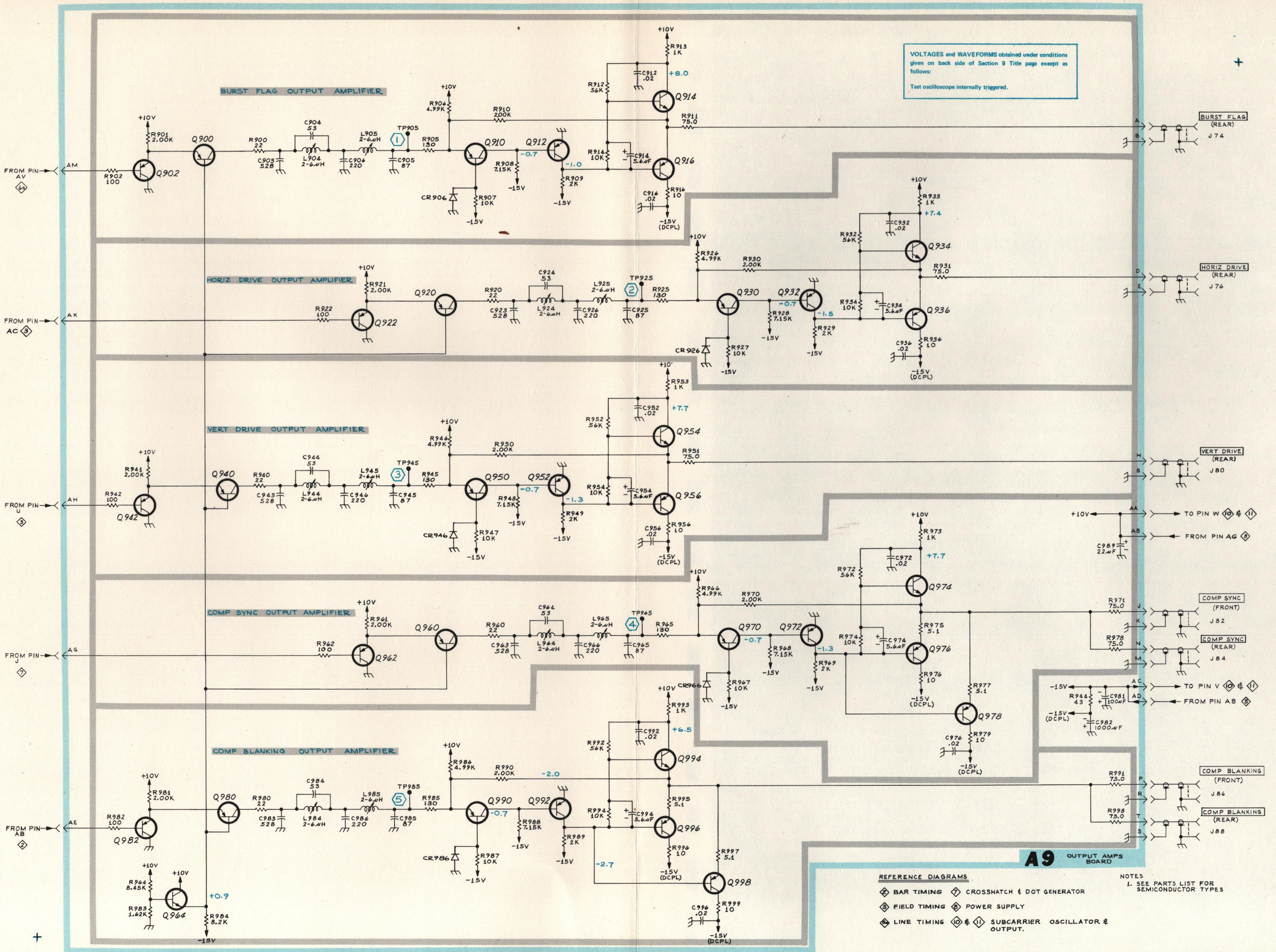
'A' grn on wht coax
'B' Shield for 'A'
'D' blu on wht coax
'E' Shield for 'D'
'G' Shield for 'H'
'H' yel on wht coax
'J' blk-grn on wht coax
'K' Shield for 'J'

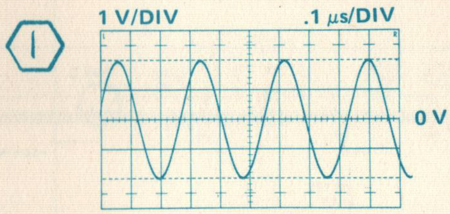
'M' Shield for 'N'
'N' brn on wht coax
'P' blk-blu on wht coax
'R' Shield for 'P'
'S' Shield for 'T'
'T' red on wht coax
'AA' brn on red
'AB' brn on red

'AC' blk on vio
'AD' blk on vio
'AE' brn-orn on wht
'AG' yel on wht
'AH' brn on wht
'AK' grn on wht
'AM' blk-vio on wht

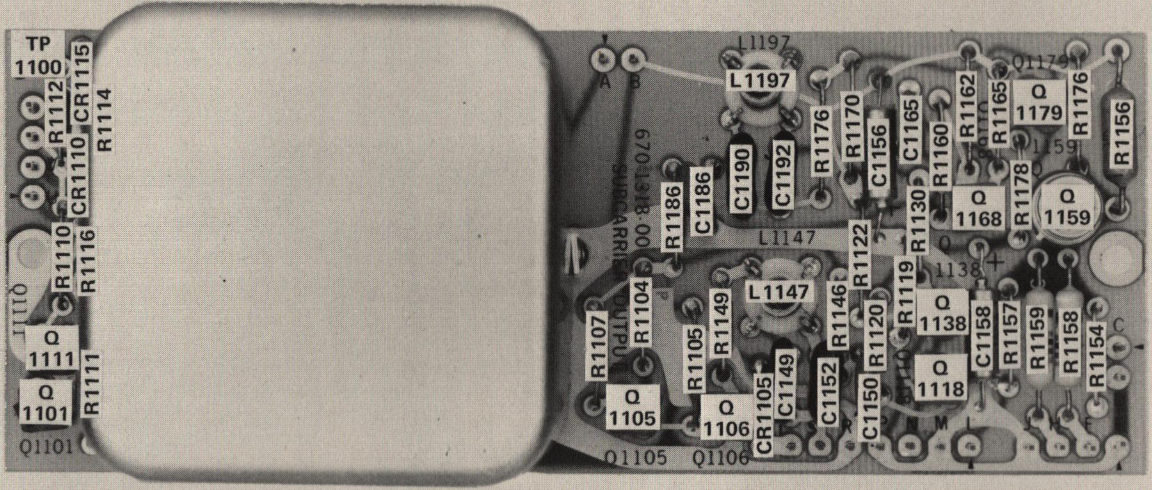


Output Amps A9


VOLTAGES and WAVEFORMS obtained under conditions given on back side of Section 9 Title page except as follows:
Test oscilloscope internally triggered.
BURST FLAG OUTPUT AMPLIFIER
HORIZ DRIVE OUTPUT AMPLIFIER
VERT DRIVE OUTPUT AMPLIFIER
COMP SYNC OUTPUT AMPLIFIER
COMP BLANKING OUTPUT AMPLIFIER
BURST FLAG (REAR) J74
HORIZ DRIVE (REAR) J76
VERT DRIVE (REAR) J80
COMP SYNC (FRONT) J82
COMP SYNC (REAR) J84
COMP BLANKING (FRONT) J86
COMP BLANKING (REAR) J88
TO PIN W 10 & 11
FROM PIN AG 8
TO PIN V 10 & 11
FROM PIN AB 8
A9 OUTPUT AMPS BOARD
REFERENCE DIAGRAMS
2 BAR TIMING
3 FIELD TIMING
4 LINE TIMING
7 CROSSHATCH & DOT GENERATOR
8 POWER SUPPLY
10 & 11 SUBCARRIER OSCILLATOR & OUTPUT.
NOTES
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

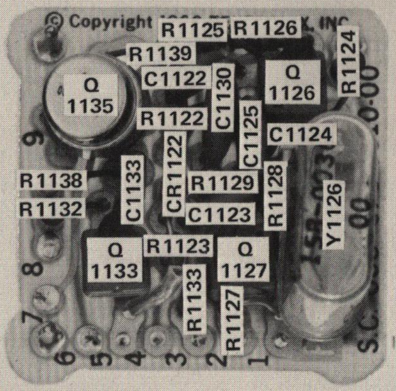


1
1 V/DIV
.1 μs/DIV
0 V



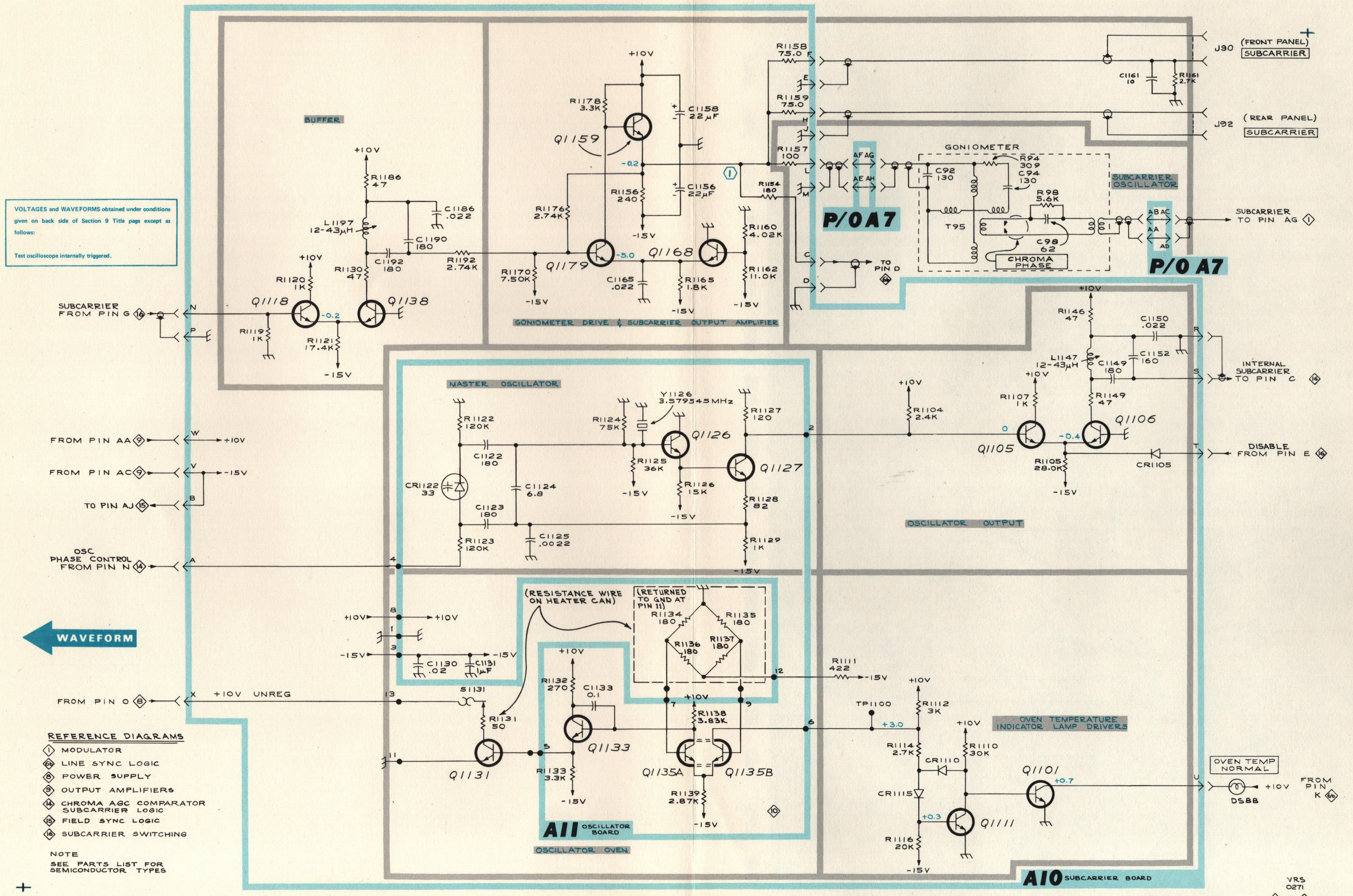
Subcarrier Output A10

'A' blk on wht
'B' blk on vio
'C' red-blk on wht coax
'D' Shield for 'C'
'E' Shield for 'F'
'F' orn-blk on wht coax
'H' red on wht coax
'J' Shield for 'H'
'L' wht coax
'M' Shield for 'L'
'N' blu on wht coax
'P' Shield for 'N'
'R' Shield for 'S'
'S' gry on wht coax
'T' blk-orn on wht
'U' yel on wht
'V' blk on vio
'W' brn on red
'X' blk on wht



SC Osc A11

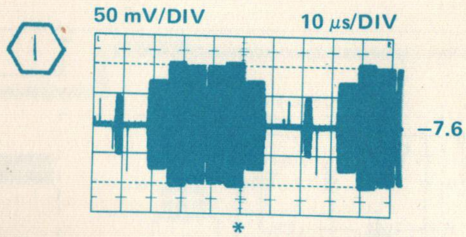
Ⓐ

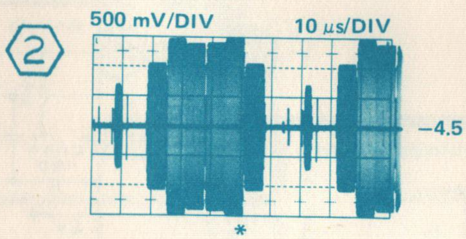


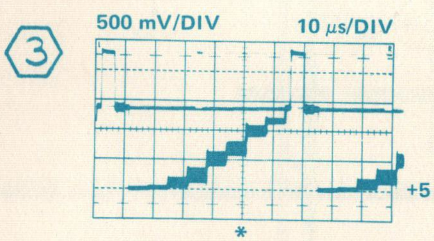
146 /R146

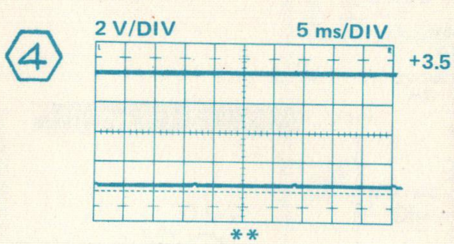
SUBCARRIER OSCILLATOR & OUTPUT 10 & 11

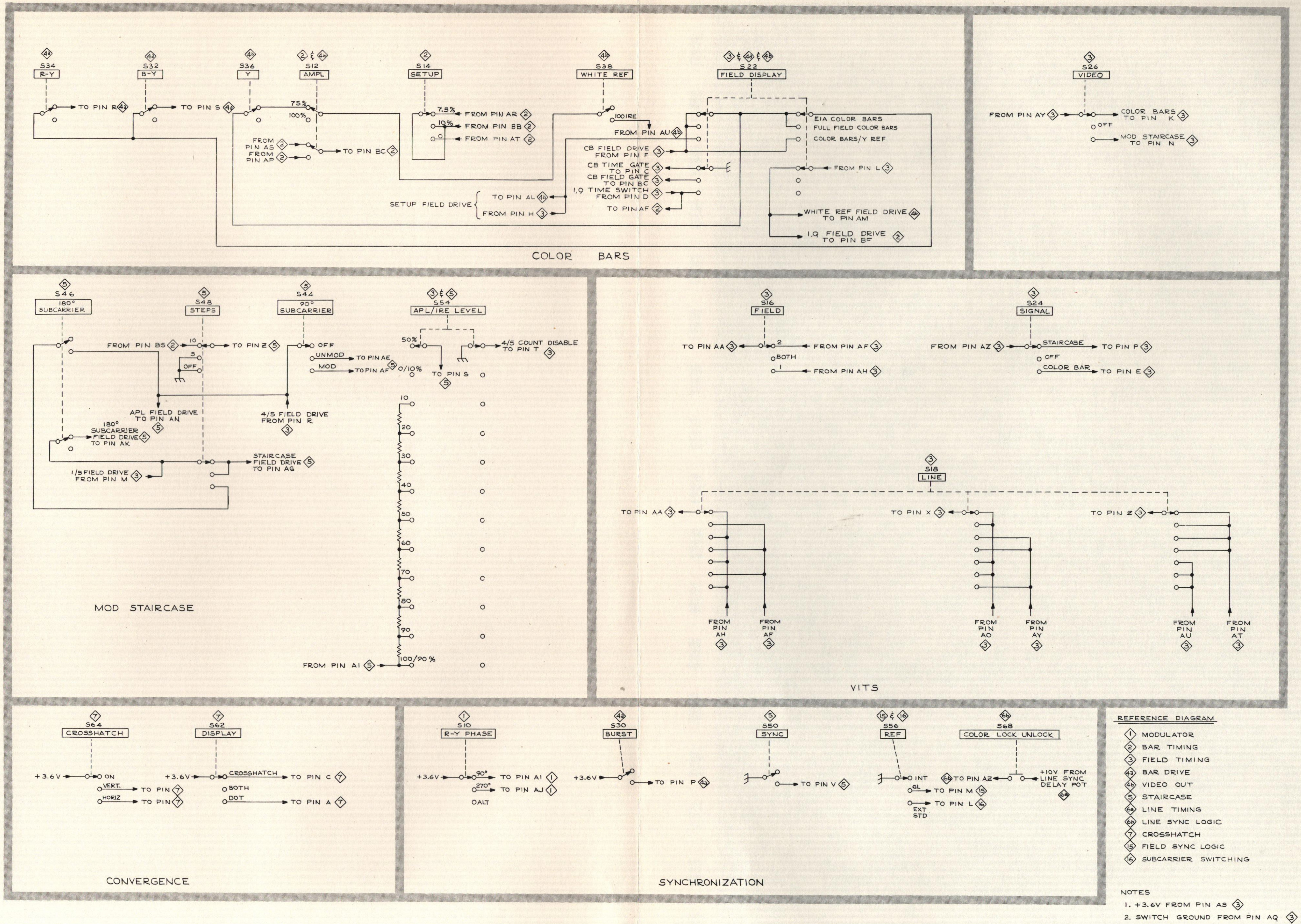
SUBCARRIER OSCIL-LATOR & OUTPUT 10 & 11


1
50 mV/DIV
10 μs/DIV
−7.6
*

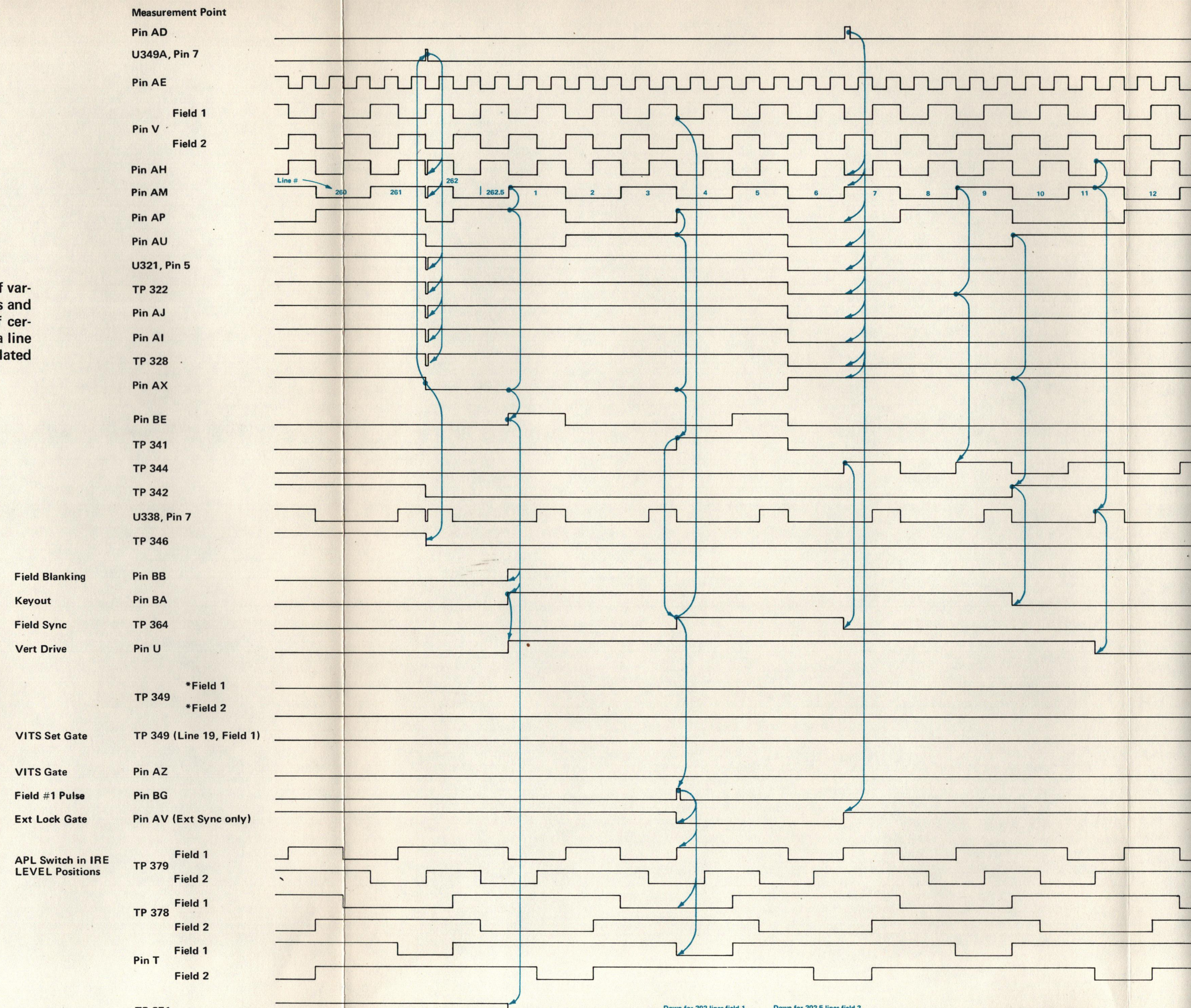

2
500 mV/DIV
10 μs/DIV
−4.5
*


3
500 mV/DIV
10 μs/DIV
+5
*

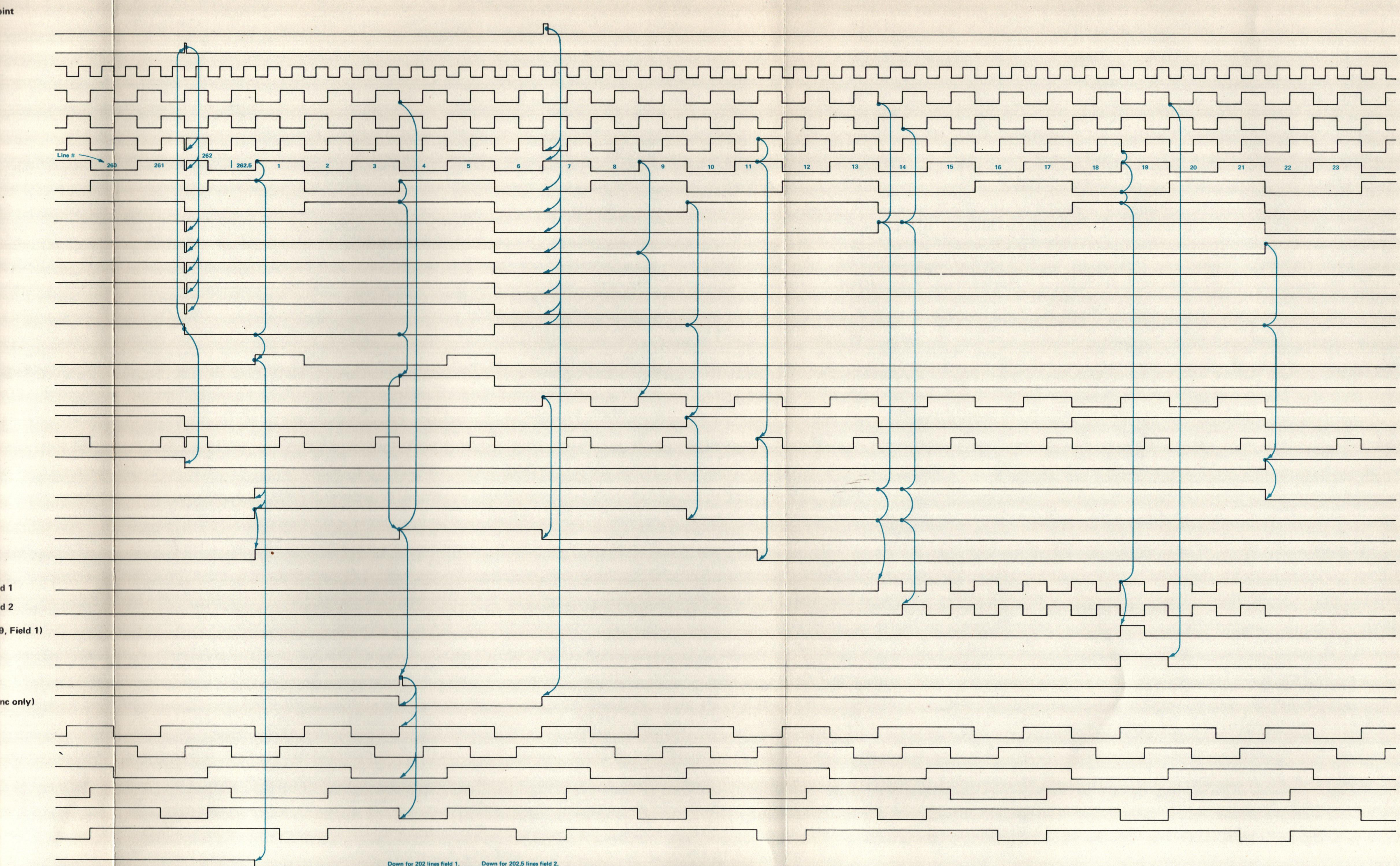

4
2 V/DIV
5 ms/DIV
+3.5
**


S34 R-Y
TO PIN R
S32 B-Y
TO PIN S
S36 Y
S12 AMPL
75%
100%
FROM PIN AS
FROM PIN AP
TO PIN BC
S14 SETUP
7.5%
10%
FROM PIN AR
FROM PIN BB
FROM PIN AT
S38 WHITE REF
100IRE
FROM PIN AU
S22 FIELD DISPLAY
EIA COLOR BARS
FULL FIELD COLOR BARS
COLOR BARS/Y REF
CB FIELD DRIVE FROM PIN F
CB TIME GATE TO PIN C
CB FIELD GATE TO PIN BC
I,Q TIME SWITCH FROM PIN D
TO PIN AF
FROM PIN L
SETUP FIELD DRIVE
TO PIN AL
FROM PIN H
WHITE REF FIELD DRIVE TO PIN AM
I,Q FIELD DRIVE TO PIN BF
COLOR BARS
S26 VIDEO
FROM PIN AY
COLOR BARS TO PIN K
OFF
MOD STAIRCASE TO PIN N
S46 180° SUBCARRIER
S48 STEPS
S44 90° SUBCARRIER
S54 APL/IRE LEVEL
FROM PIN BS
TO PIN Z
OFF
UNMOD
TO PIN AE
MOD
TO PIN AF
50%
0/10%
TO PIN S
4/5 COUNT DISABLE TO PIN T
APL FIELD DRIVE TO PIN AN
4/5 FIELD DRIVE FROM PIN R
180° SUBCARRIER FIELD DRIVE TO PIN AK
1/5 FIELD DRIVE FROM PIN M
STAIRCASE FIELD DRIVE TO PIN AG
10
20
30
40
50
60
70
80
90
100/90%
FROM PIN AI
MOD STAIRCASE
S16 FIELD
TO PIN AA
2
BOTH
1
FROM PIN AF
FROM PIN AH
S24 SIGNAL
FROM PIN AZ
STAIRCASE
TO PIN P
OFF
COLOR BAR
TO PIN E
S18 LINE
TO PIN AA
TO PIN X
TO PIN Z
FROM PIN AH
FROM PIN AF
FROM PIN AO
FROM PIN AY
FROM PIN AU
FROM PIN AT
VITS
S64 CROSSHATCH
+3.6V
ON
VERT.
HORIZ
TO PIN
S62 DISPLAY
CROSSHATCH
BOTH
DOT
TO PIN C
TO PIN A
CONVERGENCE
S10 R-Y PHASE
90°
270°
ALT
TO PIN AI
TO PIN AJ
S30 BURST
TO PIN P
S50 SYNC
TO PIN V
S56 REF
INT
GL
EXT STD
TO PIN M
TO PIN L
S68 COLOR LOCK UNLOCK
TO PIN AZ
+10V FROM LINE SYNC DELAY POT
SYNCHRONIZATION
REFERENCE DIAGRAM
1 MODULATOR
2 BAR TIMING
3 FIELD TIMING
4a BAR DRIVE
4b VIDEO OUT
5 STAIRCASE
6a LINE TIMING
6b LINE SYNC LOGIC
7 CROSSHATCH
15 FIELD SYNC LOGIC
16 SUBCARRIER SWITCHING
NOTES
1. +3.6V FROM PIN AS 3
2. SWITCH GROUND FROM PIN AQ 3

Time-related waveforms showing relation of various input and output signals at pin connectors and test points. Dots indicate the origin points of certain causative events. Arrows at points along a line indicate the resulting action of one or more related signals.



*NOTE: These pulses are not all present during any one period of time, but represent the signal at TP 349 with the VITS LINE and FIELD switches set to each possible selection.



FIELD DETAIL TIMING

*NOTE: These pulses are not all present during any one period of time, but represent the signal at TP 349 with the VITS LINE and FIELD switches set to each possible selection.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
   . Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF
MECHANICAL PARTS LIST & ILLUSTRATIONS

SECTION 10
MECHANICAL PARTS LIST

FIGURE 1 FRONT & CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-1	333-1398-00			1	PANEL, front
-2	366-0498-00			1	KNOB, gray—CHROMA PHASE
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-1026-00			1	KNOB, gray—HORIZ POSITION
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-4	366-1026-00			1	KNOB, gray—VERT POSITION
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-0500-00			1	KNOB, gray—LINE
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-0500-00			1	KNOB, gray—APL %
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-7	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: *(not included w/resistor)*
-8	210-0590-00			1	NUT, hex., 0.375-32 x 0.438 inch
-9	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD
-10	119-0133-00			1	GONIOMETER, *w/hardware*
	- - - - - -			-	mounting hardware: *(not included w/goniometer)*
-11	210-1106-00			1	WASHER, spring tension, 0.205 ID x 0.50 inch OD
-12	210-0894-00			1	WASHER, plastic, 0.19 ID x 0.438 inch OD
-13	220-0576-00			1	NUT, hex., 0.375-32 x 0.438 inch
-14	136-0164-00			3	SOCKET, light
	- - - - - -			-	mounting hardware for each: *(not included w/socket)*
-15	220-0480-02			1	NUT, dodecagon, 0.377-32 x 0.438 inch
-16	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD
-17	210-0012-00			1	WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-18	210-0413-00			1	NUT, hex., 0.375-32 x 0.50 inch
-19	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: *(not included w/resistor)*
-20	358-0054-00			1	BUSHING
-21	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-22	210-0471-00			1	NUT, hex., 0.25-32 x 0.312 inch
-23	260-0247-00			1	SWITCH, pushbutton—COLOR LOCK/UNLOCK
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-24	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-25	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD

FIGURE 1 FRONT & CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-26	260-1087-00			1	SWITCH, rotary—LINE
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-27	210-0590-00			1	NUT, hex., 0.375-32 x 0.438 inch
-28	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD
-29	260-1088-00			1	SWITCH, rotary—APL %
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-30	210-0590-00			1	NUT, hex., 0.375-32 x 0.438 inch
-31	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD
-32	260-0276-00			1	SWITCH, toggle—POWER
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-33	210-0473-00			1	NUT, dodecagon, 0.469-32 x 0.634 inch
-34	210-0902-00			1	WASHER, flat, 0.47 ID x 0.656 inch OD
-35	354-0055-00			1	RING, locking
-36	337-1155-00			1	SHIELD, switch
-37	210-0414-00			1	NUT, hex., 0.469-32 x 0.638 inch
-38	366-0215-02			19	KNOB, gray, lever switch
-39	260-0621-00			1	SWITCH, lever—REF
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-40	260-0731-00			1	SWITCH, lever—SYNC
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-41	260-0731-00			1	SWITCH, lever—BURST
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-42	260-0621-00			1	SWITCH, lever—R-Y PHASE
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-43	260-0621-00			1	SWITCH, lever—DISPLAY
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-44	260-0621-00			1	SWITCH, lever—CROSS HATCH
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting

FIGURE 1 FRONT & CABINET (cont)

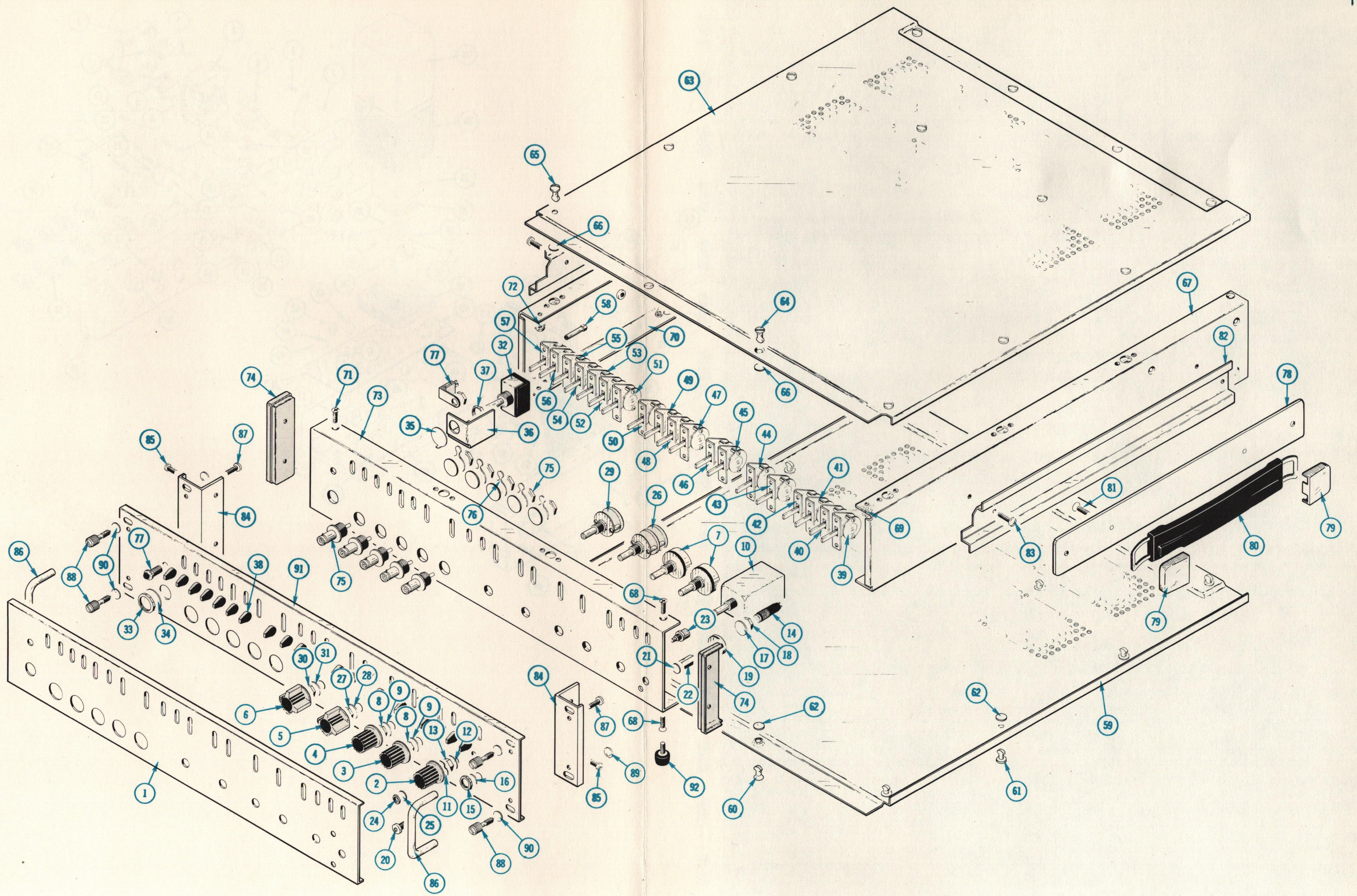
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-45	260-0621-00			1	SWITCH, lever—SIGNAL
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-46	260-0621-00			1	SWITCH, lever—FIELD
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-47	260-0621-00			1	SWITCH, lever—90° SUBCARRIER
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-48	260-0820-00			1	SWITCH, lever—STEPS
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-49	260-0664-00			1	SWITCH, lever—180° SUBCARRIER
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-50	260-0621-00			1	SWITCH, lever—VIDEO
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-51	260-0807-00			1	SWITCH, lever—FIELD DISPLAY
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-52	260-0731-00			1	SWITCH, lever—WHITE REF
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-53	260-0621-00			1	SWITCH, lever—SETUP
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-54	260-0664-00			1	SWITCH, lever—AMPL
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting

FIGURE 1 FRONT & CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-55	260-0731-00			1	SWITCH, lever—Y
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-56	260-0731-00			1	SWITCH, lever—B-Y
	- - - - - -			-	mounting hardware: *(not included w/switch)*
	220-0413-00			2	NUT, switch mounting
-57	260-0731-00			1	SWITCH, lever—R-Y
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-58	220-0413-00			2	NUT, switch mounting
-59	390-0063-00			1	CABINET BOTTOM
	- - - - - -			-	cabinet bottom includes:
-60	355-0134-00			2	STUD, turnlock fastener, FHS
-61	355-0135-00			12	STUD, turnlock fastener, OHS
-62	214-0389-00			14	FASTENER, retainer
-63	390-0112-00			1	CABINET TOP
	- - - - - -			-	cabinet top includes:
-64	355-0134-00			2	STUD, turnlock fastener, FHS
-65	355-0135-00			12	STUD, turnlock fastener, OHS
-66	214-0389-00			14	FASTENER, retainer
-67	390-0065-00			1	CABINET SIDE, right
	- - - - - -			-	mounting hardware: *(not included w/cabinet side)*
-68	211-0538-00			10	SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-69	210-0457-00			10	NUT, keps, 6-32 x 0.312 inch
-70	390-0066-00			1	CABINET SIDE, left
	- - - - - -			-	mounting hardware: *(not included w/cabinet side)*
-71	211-0538-00			10	SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-72	210-0457-00			10	NUT, keps, 6-32 x 0.312 inch
-73	386-1924-00			1	SUBPANEL, front
-74	124-0216-00			2	STRIP, trim, plastic *(146 only)*
	- - - - - -			-	mounting hardware for each: *(not included w/strip)*
	212-0068-00			2	SCREW, 8-32 x 0.312 inch, THS
-75	131-0126-00			5	CONNECTOR, coaxial, 1 contact, BNC, female, *w/hardware*
	- - - - - -			-	mounting hardware for each: *(not included w/connector)*
-76	210-0241-00			1	LUG, terminal, 0.515 ID x 0.625 inch OD

FIGURE 1 FRONT & CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-77	136-0079-00			1	SOCKET ASSEMBLY, *w/green jewel and hardware*
-78	386-1663-00			1	PLATE, handle mounting *(146 only)*
	- - - - - -			-	plate includes:
-79	344-0098-00			2	CLIP
-80	367-0037-00			1	HANDLE
	- - - - - -			-	mounting hardware: *(not included w/handle)*
-81	212-0506-00			2	SCREW, 10-32 x 0.375 inch, 100° csk, FHS
	- - - - - -			-	mounting hardware: *(not included w/plate)*
	212-0507-00			2	SCREW, 10-32 x 0.375 inch, PHS
-82	351-0104-00			1	SLIDE, section *(pair, R146 only)*
	- - - - - -			-	mounting hardware for each: *(not included w/slide)*
-83	212-0004-00			2	SCREW, 8-32 x 0.312 inch, PHS
-84	407-0510-00			2	BRACKET, angle *(R146 only)*
	- - - - - -			-	mounting hardware: *(not included w/bracket)*
-85	212-0004-00			2	SCREW, 8-32 x 0.312 inch, PHS
-86	367-0102-00			2	HANDLE, carrying *(R146 only)*
	- - - - - -			-	mounting hardware for each: *(not included w/handle)*
-87	212-0004-00			2	SCREW, 8-32 x 0.312 inch, PHS
-88	213-0216-00			4	THUMBSCREW, 10-32 x 0.75 inch *(R146 only)*
	- - - - - -			-	mounting hardware for each: *(not included w/thumbscrew)*
-89	354-0025-00			1	RING, retaining
-90	210-0894-00			1	WASHER, plastic
-91	333-1399-00			1	PANEL, front *(R146 only)*
-92	348-0048-00			4	FOOT, cabinet *(146 only)*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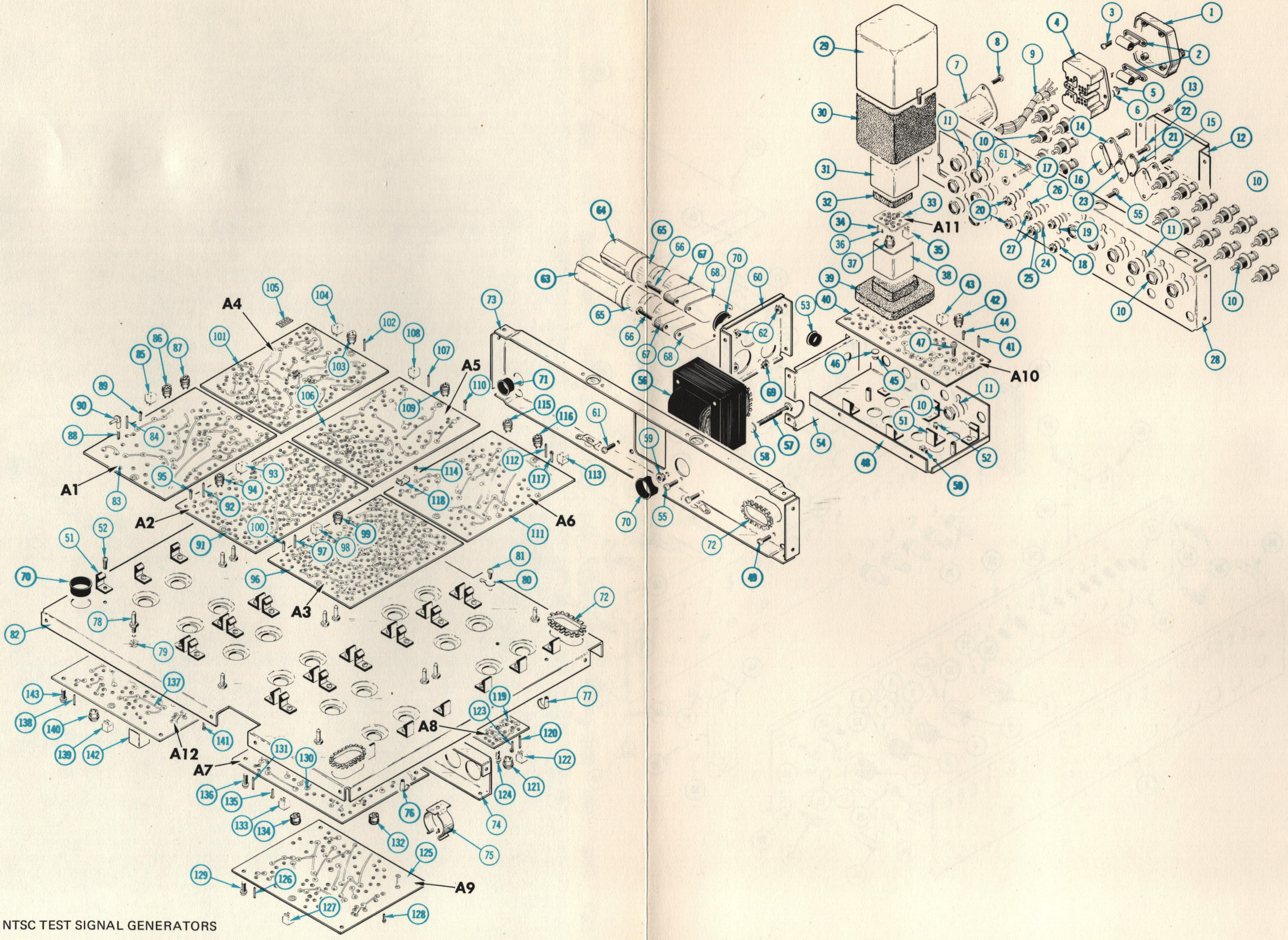
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FIGURE 2 CHASSIS & REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-1	200-0762-00			1	COVER, line voltage selector
	- - - - - -			-	cover includes:
-2	352-0102-00			2	HOLDER, fuse, plastic
	- - - - - -			-	mounting hardware: *(not included w/holder)*
-3	213-0088-00			2	SCREW, thread forming, 4-40 x 0.25 inch, PHS
-4	204-0279-00			1	BODY, line voltage selector
	- - - - - -			-	mounting hardware: *(not included w/body)*
-5	210-0407-00			2	NUT, hex., 6-32 x 0.25 inch
-6	210-0006-00			2	WASHER, lock, internal, 0.146 ID x 0.283 inch OD
-7	- - - - - -			1	LINE FILTER
	- - - - - -			-	mounting hardware: *(not included w/line filter)*
-8	211-0507-00			2	SCREW, 6-32 x 0.312 inch, PHS
	211-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-9	179-1399-00			1	WIRING HARNESS, line voltage selector
-10	131-0126-00			18	CONNECTOR, coaxial, 1 contact, BNC, female, *w/hardware*
	- - - - - -			-	mounting hardware for each: *(not included w/connector)*
-11	210-0241-00			1	LUG, terminal, 0.515 ID x 0.625 inch OD
-12	200-0918-01			1	COVER, transistor
	- - - - - -			-	mounting hardware: *(not included w/cover)*
-13	211-0008-00			4	SCREW, 4-40 x 0.25 inch, PHS
-14	- - - - - -			2	TRANSISTOR
	- - - - - -			-	mounting hardware for each: *(not included w/transistor)*
-15	211-0510-00			2	SCREW, 6-32 x 0.375 inch, PHS
-16	386-0978-00			1	PLATE, insulator
-17	210-0975-00			2	WASHER, plastic, shouldered, 0.14 ID x 0.375 inch OD
-18	210-0803-00			2	WASHER, flat, 0.14 ID x 0.375 inch OD
-19	210-0202-00			1	LUG, solder, SE #6
-20	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-21	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: *(not included w/transistor)*
-22	211-0510-00			2	SCREW, 6-32 x 0.375 inch, PHS
-23	386-0143-00			1	PLATE, insulating
-24	210-0935-00			2	WASHER, fiber, shouldered, 0.14 ID x 0.375 inch OD
-25	210-0803-00			2	WASHER, flat, 0.15 ID x 0.375 inch OD
-26	210-0202-00			1	LUG, solder, SE #6
-27	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-28	386-1606-02			1	PANEL, rear

FIGURE 2 CHASSIS & REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-	119-0273-00			1	OVEN ASSEMBLY
	- - - - - -			-	oven assembly includes:
-29	200-0906-01			1	COVER, oven assembly
-30	214-1097-01			1	INSULATOR, oven, thermal
-31	200-0769-00			1	COVER, oven, inner
-32	348-0126-00			1	PAD, cushioning
-33	670-0310-00			1	CIRCUIT BOARD ASSEMBLY—S.C. OSC A11
	- - - - - -			-	circuit board assembly includes:
	388-1327-00			1	CIRCUIT BOARD
-34	131-0633-00			3	TERMINAL, pin, 0.385 inch long
-35	136-0220-00			3	SOCKET, transistor, 3 pin, square
-36	136-0234-00			2	RECEPTACLE, electrical
-37	136-0235-00			1	SOCKET, transistor, 6 pin
-38	205-0108-01			1	SHELL, oven
-39	214-1096-00			1	INSULATOR, oven, thermal
-40	670-1318-00			1	CIRCUIT BOARD ASSEMBLY—SUBCARRIER OUTPUT A10
	- - - - - -			-	circuit board assembly includes:
	388-1887-00			1	CIRCUIT BOARD
-41	131-0589-00			19	TERMINAL, pin, 0.50 inch long
-42	136-0183-00			1	SOCKET, transistor, 3 pin
-43	136-0220-00			8	SOCKET, transistor, 3 pin, square
-44	214-0579-00			1	PIN, test point
-45	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch
-46	210-1002-00			2	WASHER, flat, 0.125 ID x 0.25 inch OD
	- - - - - -			-	mounting hardware: *(not included w/oven assembly)*
-47	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB
-48	441-0892-00			1	CHASSIS, oven
	- - - - - -			-	mounting hardware: *(not included w/chassis)*
-49	211-0504-00			2	SCREW, 6-32 x 0.25 inch, PHS
-50	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-51	344-0133-00			30	CLIP, circuit board
	- - - - - -			-	mounting hardware for each: *(not included w/clip)*
-52	213-0138-00			1	SCREW, sheet metal, #4 x 0.188 inch, PHS
-53	348-0064-00			1	GROMMET, plastic, 0.625 inch diameter
-54	407-0555-00			1	BRACKET, transformer
	- - - - - -			-	mounting hardware: *(not included w/bracket)*
-55	211-0507-00			4	SCREW, 6-32 x 0.312 inch
	210-0457-00			4	NUT, keps, 6-32 x 0.312 inch
-56	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: *(not included w/transformer)*
-57	212-0516-00			4	SCREW, 10-32 x 2 inches, HSS
-58	210-0812-00			4	WASHER, fiber, shouldered, #10
	166-0227-00			4	TUBE, insulating, plastic
-59	220-0410-00			4	NUT, keps, 10-32 x 0.375 inch

FIGURE 2 CHASSIS & REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-60	407-0556-00			1	BRACKET, capacitor
	- - - - - -			-	mounting hardware: *(not included w/bracket)*
-61	211-0507-00			4	SCREW, 6-32 x 0.312 inch, PHB
-62	210-0457-00			4	NUT, keps, 6-32 x 0.312 inch
-63	200-0293-00			1	COVER, capacitor, plastic, 1.369 ID x 2.563 inches long
-64	200-0538-00			1	COVER, capacitor, plastic, 1.369 ID x 1.644 inches long
-65	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: *(not included w/capacitor)*
-66	211-0588-00			2	SCREW, 6-32 x 0.75 inch, PHB
-67	432-0048-00			1	BASE, capacitor, plastic
-68	386-0254-00			1	PLATE, fiber, large
-69	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-70	348-0050-00			4	GROMMET, plastic, 0.75 inch diameter
-71	348-0063-00			2	GROMMET, plastic, 0.50 inch diameter
-72	255-0334-00			ft	PLASTIC CHANNEL, 3 lengths of 3.75 inches each
-73	386-1487-00			1	SUPPORT, bracket
-74	386-1532-00			1	SUPPORT, chassis
-75	344-0118-00			2	CLIP, capacitor mounting
	- - - - - -			-	mounting hardware for each: *(not included w/clip)*
	211-0504-00			1	SCREW, 6-32 x 0.25 inch, PHS
-76	343-0088-00			2	CLAMP, cable, plastic, small
-77	343-0089-00			1	CLAMP, cable, plastic, large
-78	214-1169-00			12	PIN, guide
	- - - - - -			-	mounting hardware for each: *(not included w/pin)*
-79	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
-80	210-0201-00			6	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: *(not included w/lug)*
-81	213-0044-00			1	SCREW, thread forming, 5-32 x 0.188 inch, PHS
-82	441-0824-01			1	CHASSIS, main
-33	670-0301-01			1	CIRCUIT BOARD ASSEMBLY—MODULATOR A1
	- - - - - -			-	circuit board assembly includes:
	388-1318-01			1	CIRCUIT BOARD
-84	131-0589-00			30	TERMINAL, pin, 0.50 inch long
-85	136-0220-00			22	SOCKET, transistor, 3 pin, square
-86	136-0235-00			2	SOCKET, transistor, 6 pin
-87	136-0237-00			1	SOCKET, integrated circuit, 8 pin
-88	214-0506-00			4	PIN, connector
-89	214-0579-00			10	PIN, test point
-90	352-0134-00			4	HOLDER, toroid

FIGURE 2 CHASSIS & REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-91	670-0302-02			1	CIRCUIT BOARD ASSEMBLY—BAR TIMING A2
	- - - - - -			-	circuit board assembly includes:
	388-1319-01			1	CIRCUIT BOARD
-92	131-0589-00			50	TERMINAL, pin, 0.50 inch long
-93	136-0220-00			22	SOCKET, transistor, 3 pin, square
-94	136-0237-00			20	SOCKET, integrated circuit, 8 pin
-95	214-0579-00			6	PIN, test point
-96	670-1000-00			1	CIRCUIT BOARD ASSEMBLY—FIELD TIMING A3
	- - - - - -			-	circuit board assembly includes:
	388-1886-00			1	CIRCUIT BOARD
-97	131-0589-00			55	TERMINAL, pin, 0.50 inch long
-98	136-0220-00			16	SOCKET, transistor, 3 pin, square
-99	136-0237-00			36	SOCKET, integrated circuit, 8 pin
-100	214-0579-00			11	PIN, test point
-101	670-0959-01			1	CIRCUIT BOARD ASSEMBLY—BAR DRIVE/VIDEO OUT A4
	- - - - - -			-	circuit board assembly includes:
	388-1753-00			1	CIRCUIT BOARD
-102	131-0589-00			49	TERMINAL, pin, 0.50 inch long
-103	136-0183-00			2	SOCKET, transistor, 3 pin
-104	136-0220-00			41	SOCKET, transistor, 3 pin, square
-105	136-0337-00			1	SOCKET, relay, 8 pin
-106	670-1347-00			1	CIRCUIT BOARD ASSEMBLY—STAIRCASE A5
	- - - - - -			-	circuit board assembly includes:
	388-1906-00			1	CIRCUIT BOARD
-107	131-0589-00			23	TERMINAL, pin, 0.50 inch long
-108	136-0220-00			27	SOCKET, transistor, 3 pin, square
-109	136-0237-00			13	SOCKET, integrated circuit, 8 pin
-110	214-0579-00			7	PIN, test point
-111	670-1322-00			1	CIRCUIT BOARD ASSEMBLY—LINE TIMING A6
	- - - - - -			-	circuit board assmbly includes:
	388-1876-00			1	CIRCUIT BOARD
-112	131-0589-00			35	TERMINAL, pin, 0.50 inch long
	131-0608-00			3	TERMINAL, pin, 0.365 inch long
-113	136-0220-00			31	SOCKET, transistor, 3 pin, square
-114	136-0234-00			2	SOCKET, receptacle, electrical, 0.12 OD x 0.247 inch
-115	136-0235-00			1	SOCKET, transistor, 6 pin
-116	136-0237-00			21	SOCKET, integrated circuit, 8 pin
-117	214-0579-00			20	PIN, test point
-118	352-0096-00			1	HOLDER, crystal
-119	670-0324-01			1	CIRCUIT BOARD ASSEMBLY—POWER SUPPLY A8
	- - - - - -			-	circuit board assembly includes;
	388-1467-01			1	CIRCUIT BOARD
-120	131-0589-00			39	TERMINAL, pin, 0.50 inch long
-121	136-0183-00			3	SOCKET, transistor, 3 pin
-122	136-0220-00			10	SOCKET, transistor, 3 pin, square
-123	214-0579-00			4	PIN, test point
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-124	211-0116-00			3	SCREW, sems, 4-40 x 0.312 inch, PHB

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FIGURE 2 CHASSIS & REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-125	670-0308-00			1	CIRCUIT BOARD ASSEMBLY—OUTPUT AMPS A9
	- - - - - -			-	circuit board assembly includes:
	388-1325-00			1	CIRCUIT BOARD
-126	131-0589-00			23	TERMINAL, pin, 0.50 inch long
-127	136-0220-00			33	SOCKET, transistor, 3 pin square
-128	214-0579-00			7	PIN, test point
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-129	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
-130	670-0957-00			1	CIRCUIT BOARD ASSEMBLY—CROSS HATCH A7
	- - - - - -			-	circuit board assembly includes:
	388-1751-00			1	CIRCUIT BOARD
-131	131-0589-00			30	TERMINAL, pin, 0.50 inch long
	131-0633-00			4	TERMINAL, pin, 0.385 inch long
-132	136-0183-00			1	SOCKET, transistor, 3 pin
-133	136-0220-00			25	SOCKET, transistor, 3 pin, square
-134	136-0237-00			19	SOCKET, integrated circuit, 8 pin
-135	214-0579-00			16	PIN, test point
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-136	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
-137	670-0999-00			1	CIRCUIT BOARD ASSEMBLY—GEN LOCK A12
	- - - - - -			-	circuit board assembly includes:
	388-1872-00			1	CIRCUIT BOARD
-138	131-0589-00			39	TERMINAL, pin, 0.50 inch long
	131-0608-00			3	TERMINAL, pin, 0.365 inch long
-139	136-0220-00			87	SOCKET, transistor, square
-140	136-0237-00			5	SOCKET, integrated circuit, 8 pin
-141	214-0579-00			20	PIN, test point
-142	337-1417-00			1	SHIELD
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-143	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
	179-1398-00			1	WIRING HARNESS, power
	- - - - - -			-	wiring harness includes:
	131-0621-00			21	CONNECTOR, terminal
	352-0203-00			1	HOLDER, terminal connector, 7 wire *(black)*
	352-0205-00			9	HOLDER, terminal connector, 9 wire *(black)*

FIGURE 2 CHASSIS & REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-	179-1610-00			1	WIRING HARNESS, main
	- - - - - -			-	wiring harness includes:
	131-0621-00			232	CONNECTOR, terminal
	131-0622-00			12	CONNECTOR, terminal
	131-0792-00			13	CONNECTOR, terminal
	352-0198-00			4	HOLDER, terminal connector, 2 wire *(black)*
	352-0199-00			4	HOLDER, terminal connector, 3 wire *(black)*
	352-0200-00			3	HOLDER, terminal connector, 4 wire *((black)*
	352-0201-00			4	HOLDER, terminal connector, 5 wire *(black)*
	352-0202-00			2	HOLDER, terminal connector, 6 wire *(black)*
	352-0203-00			11	HOLDER, terminal connector, 7 wire *(black)*
	352-0204-00			2	HOLDER, terminal connector, 8 wire *(black)*
	352-0205-00			3	HOLDER, terminal connector, 9 wire *(black)*
	352-0206-00			13	HOLDER, terminal connector, 10 wire *(black)*
	179-1609-00			1	WIRING HARNESS, coaxial
	- - - - - -			-	wiring harness includes:
	131-0621-00			3	CONNECTOR, terminal
	131-0622-00			25	CONNECTOR, terminal
	131-0792-00			25	CONNECTOR, terminal
	352-0198-00			3	HOLDER, terminal connector, 2 wire *(black)*
	352-0200-00			2	HOLDER, terminal connector, 4 wire *(black)*
	352-0206-00			2	HOLDER, terminal connector, 10 wire *(black)*

FIG. 3 STANDARD ACCESSORIES

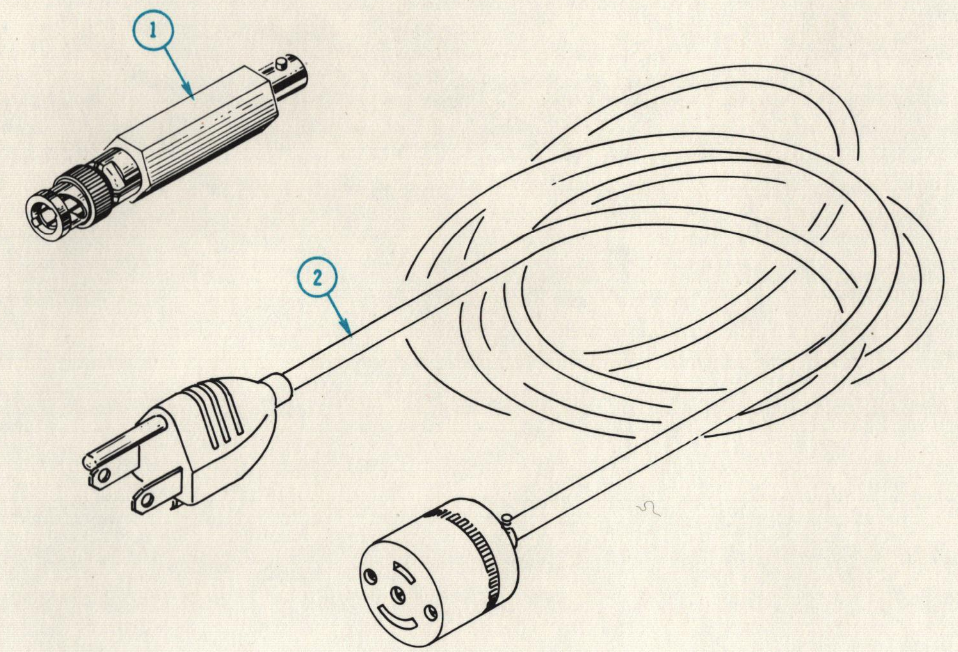
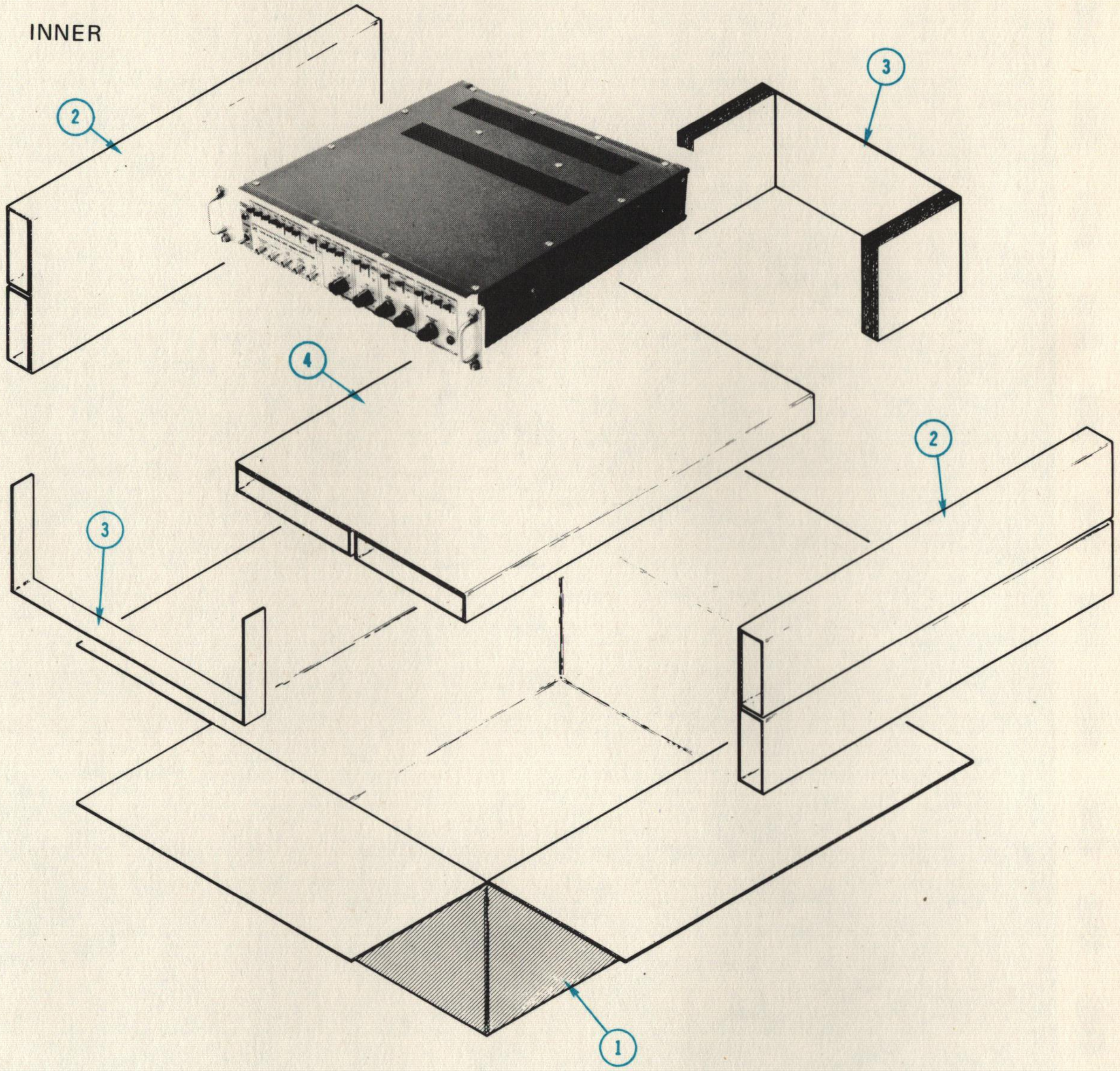


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
3-1	011-0103-02			1	TERMINATION, 75 Ω, BNC
-2	161-0036-00			1	CABLE ASSEMBLY, power, 3 wire, 7.50 feet long
	351-0195-00			1	TRACK, slide *(pair, not shown, R146 only)*
	070-1111-00			1	MANUAL, instruction *(not shown)*

CARTON ASSEMBLY
(Part No. 065-0120-00)

INNER



OUTER

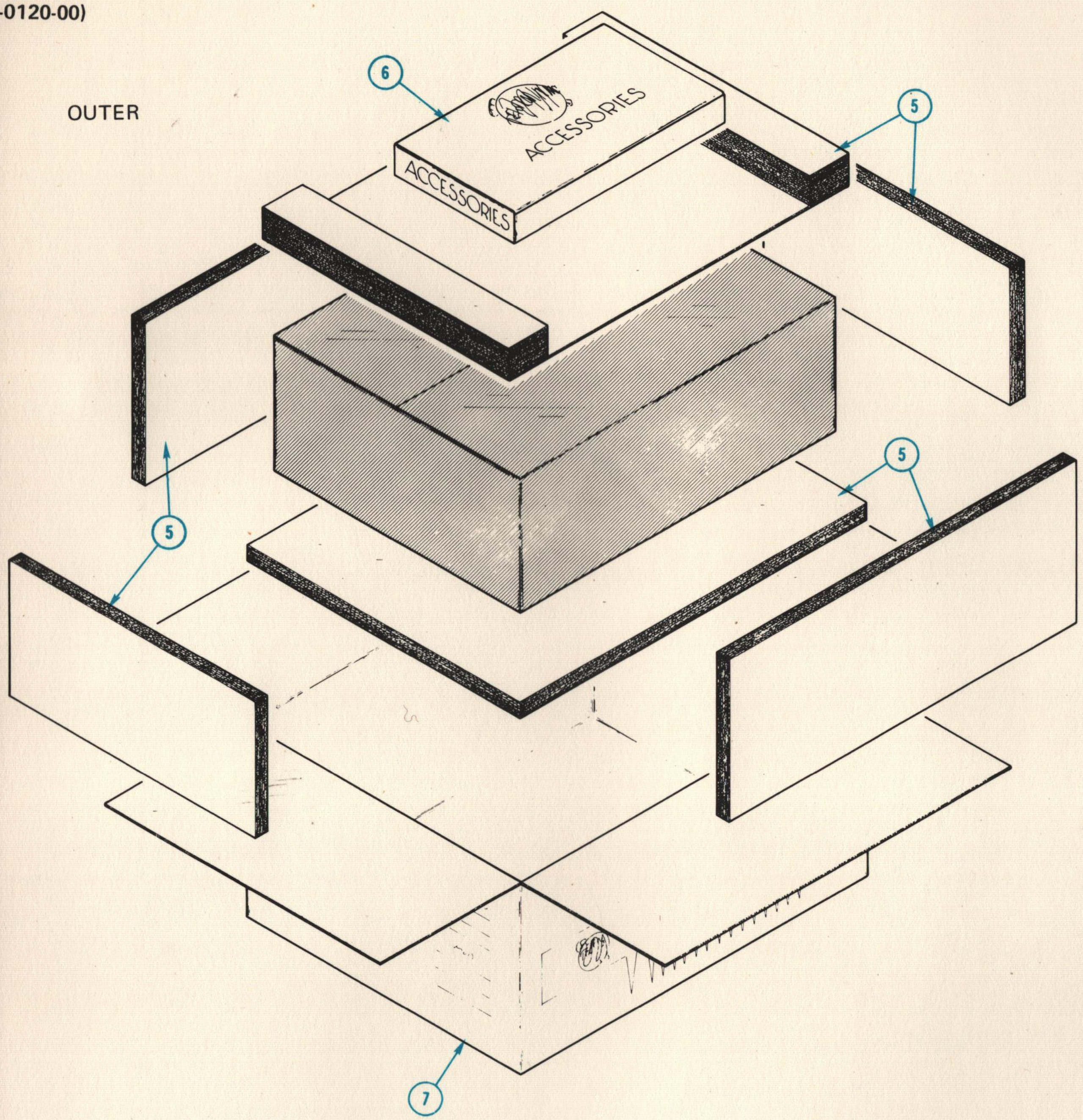


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
4-	065-0120-00			1	CARTON ASSEMBLY
	- - - - - -			-	carton assembly includes
-1	004-0460-00			1	CARTON, inner
-2	004-0360-00			1	PAD SET
-3	004-0359-00			1	PAD SET
-4	004-0357-00			3	PAD
-5	004-0361-00			1	PAD SET
-6	004-0462-00			1	CARTON, accessory
-7	004-0461-00			1	CARTON, outer

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

ELECTRICAL PARTS LIST CORRECTION

A5 STAIRCASE Circuit Board Assembly

CHANGE TO:

Q516	151-0225-00	Silicon	2N3563
Q525	151-0225-00	Silicon	2N3563
Q526	151-0225-00	Silicon	2N3563
Q535	151-0225-00	Silicon	2N3563
Q536	151-0225-00	Silicon	2N3563
Q542	151-0225-00	Silicon	2N3563
Q545	151-0225-00	Silicon	2N3563
Q546	151-0225-00	Silicon	2N3563
Q555	151-0225-00	Silicon	2N3563

TEXT CORRECTION

Section 6 Calibration

Page 6-13 Table 6-1

CHANGE: first six (6) numbers in SETUP column to read 7.5%.

CHANGE: 21st number in Chrominance column to read 373.8 within 1%.

Page 6-18 Table 6-5

CHANGE: V2 Volts Limit column to read:

548.1 to 559.1 mV
548.1 to 559.1 mV
707.2 to 721.1 mV
707.2 to 721.1 mV
707.2 to 721.1 mV

Page 6-20 Step 2 Check/Adjust Horizontal Timing
ADD: the following note after part c.

NOTE

If area F (see Fig. 6-17) is not within the listed tolerance, readjust R691 for 1.54 μs. Then, check area A.

TEXT CORRECTION

Section 6 Calibration

Page 6-26 RETURN LOSS, Step 2., parts g and j

CHANGE: to read:

g. Remove Q902, Q922, Q942, Q962............

j. Repeat the procedure (steps h and i) for the HORIZ DRIVE, VERT DRIVE, COMP SYNC and COMP BLANKING output connectors. Then, repeat the procedure for the COMP VIDEO output connectors; first with the POWER OFF, then ON.

ELECTRICAL PARTS LIST CORRECTION

POWER SUPPLY Circuit Board Assembly

CHANGE TO:

Q815	151-1004-00	FET	Silicon	N Channel-Junction Type
Q830	151-0103-00		Silicon	Replaceable by 2N2219

140/R140 TENT SN B140000-up

142/R142 TENT SN B040000-up

144/R144 TENT SN B100000-up

146/R146 TENT SN B040000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

POWER SUPPLY Circuit Board Assembly

REMOVE:

C816	283-0000-00	0.001 μF	Cer	500 V